cycles

—A MONTHLY REPORT

May 1952

FOUNDATION FOR THE STUDY OF CYCLES
New York, New York

CONTENTS

Page

THE DIRECTOR'S LETTER 159

RESEARCH

The 17¾-Year Cycle in Pig Iron Prices, 1784-1951 162
Possible Cycles in Industrial Stock Prices, 1871-1950 166
The 9.6-Year Cycle of Game Abundance 180
The 14-Day Cycle in the Amorousness of Women 181

JOURNAL OF CYCLE RESEARCH 184

FOUNDATION AFFAIRS 185

LETTERS 186

QUESTIONS & ANSWERS 189

ADDITIONS TO THE LIBRARY 191

THE FOUNDATION FOR THE STUDY OF CYCLES

The Committee of the Foundation consists of the following scientists and administrators:

UNITED STATES OF AMERICA

Copley Amory, Chairman Emeritus

Charles Greeley Abbot
Research Associate
Smithsonian Institution

Harold Elmer Anthony
Chairman and Curator
Department of Mammals
American Museum of Natural History

George Baekeland, Chairman of the
Committee of the Foundation
The Bakelite Corporation

Harold Gardiner Bowen
Vice Admiral, U.S. Navy, Retired
Executive Director, Thomas Alva
Edison Foundation

Verne Burnett
Partner
Verne Burnett Associates

Hon. W. Cameron Forbes
Member, Board of Trustees
Carnegie Institution of Washington;
Life Member of the Corporation,
Massachusetts Institute of Technology

Webster N. Jones
Dean, College of Engineering and Science
Carnegie Institute of Technology

Daniel Trembly MacDougal
Former Director
Department of Botanical Research and
Laboratory of Plant Physiology
Carnegie Institution of Washington

CANADA

Hon. Charles Camsell
Former Commissioner
Northwest Territories

Frank Cyril James
Principal and Vice-Chancellor
McGill University

GREAT BRITAIN

Sir Patrick Ashley Cooper
Governor
Hudson's Bay Company

Julian Sorrell Huxley
Former Director General
United Nations Educational, Scientific and Cultural Organizations

---

CYCLES — A Monthly Report is published by the Foundation for the Study of Cycles every month except during July and August at the Foundation's offices at 9 East 77th Street, New York 21, N. Y. Subscription rates $10.00 a year. Entered as second class matter at the Post Office at New York, N. Y. Letters for the personal attention of the Director should be sent to East Brady, Pennsylvania.

cycles

—a monthly report

The Official Bulletin of the Foundation for the Study of Cycles

VOLUME III NUMBER 5 MAY 1952

The Director's Letter

Dear Member:

Why are people so intrigued by the subject of cycles?

Of course, one reason is that a knowledge of cycles throws light on the probabilities of the future.

However, the interest in the subject of cycles runs deeper than this. There is a craving within the human heart to find regularity, dependability, and pattern in the universe. This craving may be at the bottom of much of the scientific research that has been conducted throughout the ages.

Pattern is Basic

"In the beginning was the Logos, and Logos was of God, and the Logos was God." Logos is often translated 'Word," but "pattern" is nearer to its true meaning. Men seek pattern with an almost religious intensity.

Whenever we find system, law, and regularity in phenomena previously thought of as chaotic, it gives intense satisfaction, at least to certain kinds of people.

The Idea of Order Always Resisted

On the other hand, any attempt to bring order out of chaos always meets with a great deal of resistance; sometimes in no place as vigorously as among the professionals themselves. As John Q. Stewart, professor of astronomy at Princeton, put it in speaking of the necessity of equiping social studies with methods more effective than archaic types of verbal reasoning:

'With the untrammelled enthusiasm of a youthful Ph.D. in physics, I expected to find general sympathy with this program but the case was otherwise. There is a proverb that 'In the country of the blind the one-eyed man is king,' the falsity of which has been depicted in a story by H. G. Wells. One has to find for himself that in the country of the blind—meaning university faculties and their learned societies—the one-eyed man meets with lifted eyebrows."

Economists Hostile

There are notable and brilliant exceptions but, as a class, I know of no group of men more hostile to the idea of regularly recurring cycles in human affairs than the economists. As Huck Finn puts it, they won't believe you when you tell them, and they won't look to see for themselves.

If, for example, you tell economists that peaks in prices tend to come at regularly recurring time intervals you place yourself in the position of Uvisakavsik. If you have read **Arctic Adventure** by Peter Freuchen you will remember the story:

The Story of Uvisakavsik

"In the same community lived Uvisakavsik a great hunter and important citizen, but one who had lost the respect of his people after he had returned from America, where Peary had taken him following an expedition to the Pole. It was evident to everyone that the man had taken leave of his senses. When he came ashore he lost no time in telling the most incredible yarns.

'He said that he had seen people living in big houses on top of each other, like auks in the bird cliffs. His audience let that pass. Perhaps Uvisakavsik had made a mistake. But he also told them that he had seen more ships in the harbor of New York than there were icebergs in the fjord. Smiles flicked the corners of his listeners mouths. How could anybody get wood enough to build so many ships? Then he related that he had seen real houses move on two iron bars, houses bigger than any tent, with walls of glass. Inside the houses sat many smiling people not in the least worried over their fate. Suddenly the whole house began to move away, and Uvisakavsik had seen no fear on the faces of the unfortunates trapped inside. While he had meditated this marvel he had seen several wagons roll past. There were neither dogs nor horses hitched to them, nor was there any smoke coming from them to account for the movement, as there was from ships.

'His people listened patiently and questioned. No animals to haul, no smoke to indicate machinery inside. That did not sound so good.

"Uvisakavsik kept on. He had viewed so many houses that it was impossible to see past them into the country. The paths between these houses reminded him of clefts in the mountains. Even the roads were made by human beings and covered with a smooth material which was neither cold, like ice, nor transparent.

Too Much

'His audience was plainly uneasy now. This was too much. And when he persisted, on top of everything else, that he had talked into a little handle that carried his voice through a tiny thread to Peary who was, at the time, several sleeps away, and that Uvisakavsik had spoken clearly to him without being forced to shout, his sentence was settled.

'Wise old Sorqaq,' medicine man of the tribe, stepped forward and addressed the newly arrived man solemnly:

" 'Uvisakavsik! It appears that you have been far away and no longer know the truth. Go to the women with your lies!'

"After that he was never believed. A big liar, an undependable man!"

Skepticism Desirable

Of course, skepticism is a healthy thing. Skepticism in regard to cycles is particularly justified because many of the cycles observed in natural and social phenomena are doubtless merely accidental. As such, they will not continue; they have no forecasting value.

On the other hand, it is incredible that random cycles would continue time after time *after* discovery. When cycles continue, either forward or backward from the section of time within which they are originally observed, there is probably some significance in the behavior.

One of the most important tasks in connection with the study of cycles is to determine which of the observed cycles are real and which are merely fortuitous.

* * *

My Start in Cycles

I never give a talk on the subject of cycles but that someone asks me, 'How did you get started in this subject, anyway?"

My interest in cycles began about 1932. At that time I had a job in the Department of Commerce at Washington. President Hoover wanted to know what caused depressions and one of my jobs was to try to find out by talking with economists around the country.

I was very soon impressed by the fact that although each man I talked with had very definite ideas on the subject, no two of these ideas seemed to agree. I soon came to the conclusion that for all their learned terminology these fellows did not know much more about the real underlying causes involved than I did. I knew nothing, but most of them seemed to know a lot of things that were not so.

The Behavioristic Approach

About this time, I established contact with various people who were as ignorant as I, and who knew it. They had what might be called a "behavioristic" approach to economics. These people said in effect, "We are not smart enough to know the why of things; let us, therefore, limit ourselves to the how. In studying market behavior, for example, instead of trying to figure out what makes the market go up and down, let us observe **how** it goes. Let us study past behavior and find out that the market has never gone down at a certain rapid rate of decline without going down further; that it has never gone up or down for more than so many weeks without a reaction of such and such proportions, etc., etc.

"From this sort of observation we can perhaps deduce something about future behavior, even if we do not know causes."

This point of view was refreshing. It was fun to talk with people who knew that they did not know very much.

Pattern Observed

One of the men with this behavioristic point of view was named Chapin Hoskins. Hoskins, however, went further than some of the other behaviorists. Being something of a genius, he had observed **pattern** in certain series of economic figures. He had observed, for example, that certain series of monthly bank debit figures showed rate of change peaks every three months. He found that the peaks continued after discovery and were of forecasting value.

He next discovered that, compared with the year before, certain series of figures showed peaks at 9-month intervals. These 9-month cycles also continued to come true after discovery.

Becoming intrigued, he discovered that there were longer cycles. The most important of these seemed to be about 41 months in length. This pattern also was so regular and had repeated itself so many times that it did not seem to him that it could easily be the result of chance. He began to make forecasts based on a knowledge of this cycle, too.

In 1933 I was fired by the New Deal on the grounds that I had been a "Hoover policy man." It was not true, but I have always cherished the compliment.

Some time later Hoskins suggested that I join with him in the full time study of cycles. We went into business together offering a service to corporations who wished to know something about the cycles inherent in their own sales and/or production, or the prices of their raw materials.

After a while, I discovered that the cycles that we and others were finding in economic and social affairs had their counterpart in natural science. Conferences had even been held on the subject of cycles by the Carnegie Institution of Washington, by a group of biologists in Canada, and by other organizations.

In discussing the subject with people who were concerned with these other sorts of cycles, it became apparent that if we were ever to learn anything about the subject we must attack the problem on a broad front. The Foundation for the Study of Cycles was created. I was chosen as Director. I have been "cycling" it ever since.

Very cordially yours,

Edward R. Dewey

Director

Research

THE 17¾-YEAR CYCLE IN PIG IRON PRICES

1784-1951

Summary

A cycle averaging 17 3/4-years in length is clearly evident in pig iron prices from 1784 to date. The next crest of the ideal cycle is due in 1957. This cycle is important, accounting for moves of 37% of trend, on the average. Nine and a half repetitions of the cycle in pig iron prices, and the seeming existence of the same cycle in tree rings for 900 years, and elsewhere, suggest that this cycle may be quite significant.

THE Spring 1952 issue of the quarterly **Journal of Cycle Research** carries an eleven-page article giving full details in regard to the 17 3/4-year cycle in pig iron prices in the United States. This cycle has been present in these figures from 1784, their beginning, to date—a span of 168 years.

It may be of value to give you a brief abstract of that article, and reprint for you two of the seven charts which illustrated it.

Fig. 2, reprinted on pages 164 and 165 next following, shows the Foundation's Index of Pig Iron Prices, 1784-1951, together with an 18-year centered geometric moving average trend of these values.

Fig. 4, shown below, plots the difference between the 9-year moving average and the 18-year moving average of the logs of the Index. This manipulation removes trend and minor variations. The 17 3/4-year cycle is diagramed by means of a broken line.

The last trough of the typical or ideal cycle is seen to fall in 1948.1, the next crest of the ideal cycle is is due at the end of 1956.

Cycle Important

This cycle is pretty important. At time of ideal crest prices are, on the average, 20.2% above trend; at trough, on the average, 16.9% below trend. This makes an overall move of about 37% of trend, a change of sufficient magnitude so that it cannot safely be disregarded.

If you chop the data into sections

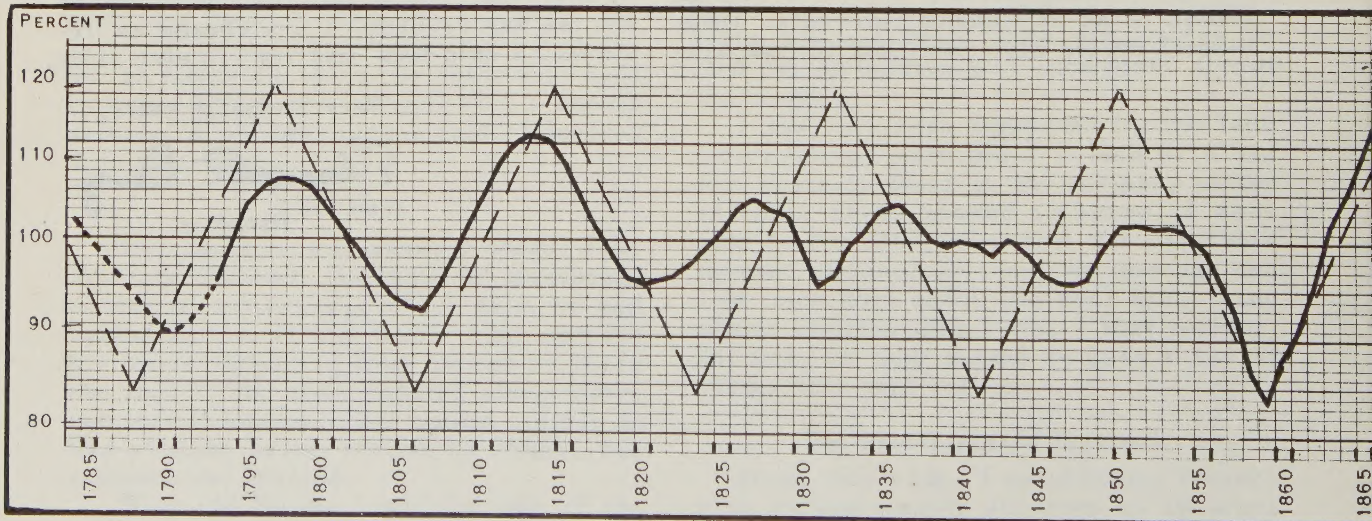


Fig. 4. Deviations of the 9-year moving average from the 18-year moving average, together with an ideal 17 3/4-year cycle shown by means of a zigzag line. Logs.

The ideal 17 3/4-year cycle has been projected into the future to show in a general which are 17 3/4 years long and average these 9 1/2 sections, you will get the values for the various points of a typical or average cycle. This has been done and the averages are plotted in Fig. 6. The averages are repeated in phantom so as to give you two complete 17 3/4-year waves.

Is this cycle the result of ten different causes which just happened to come about 17 3/4 years apart? Or is there significance to the regularity? No one knows, but to be on the safe side you had better not ignore the possibility that the cycle is real and will continue.

First Discovered in 1942

The first time I ever came across a cycle of this length, as best I can remember, was in 1942. I found it in connection with a multiple harmonic analysis of cotton prices made at that time. Cotton prices start in 1731 and therefore give you three way what will happen if this cycle continues.

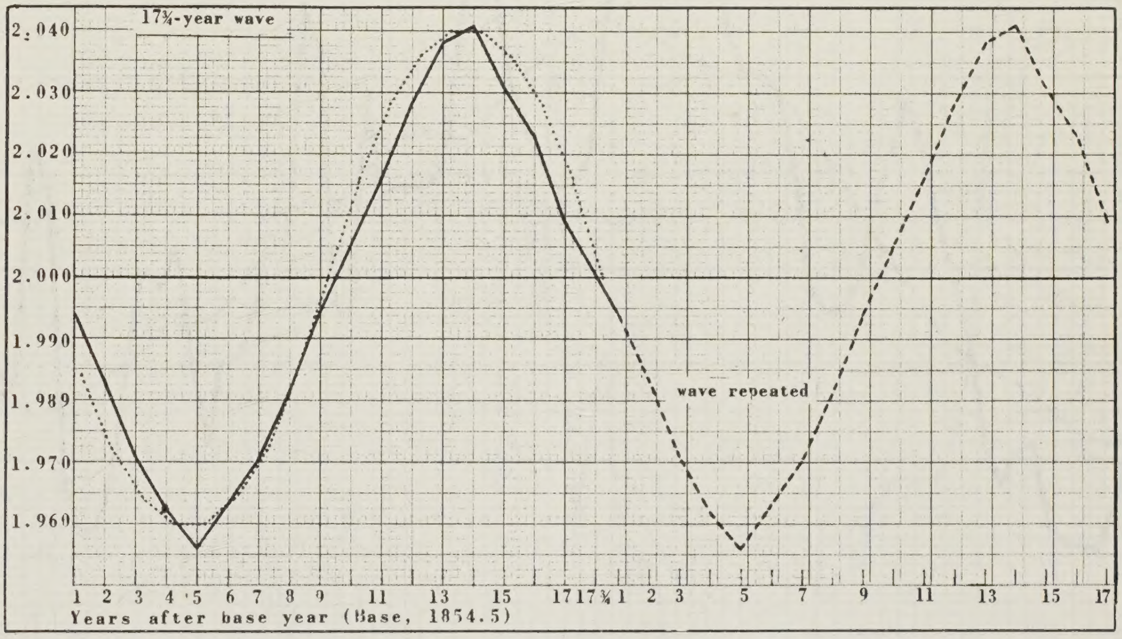
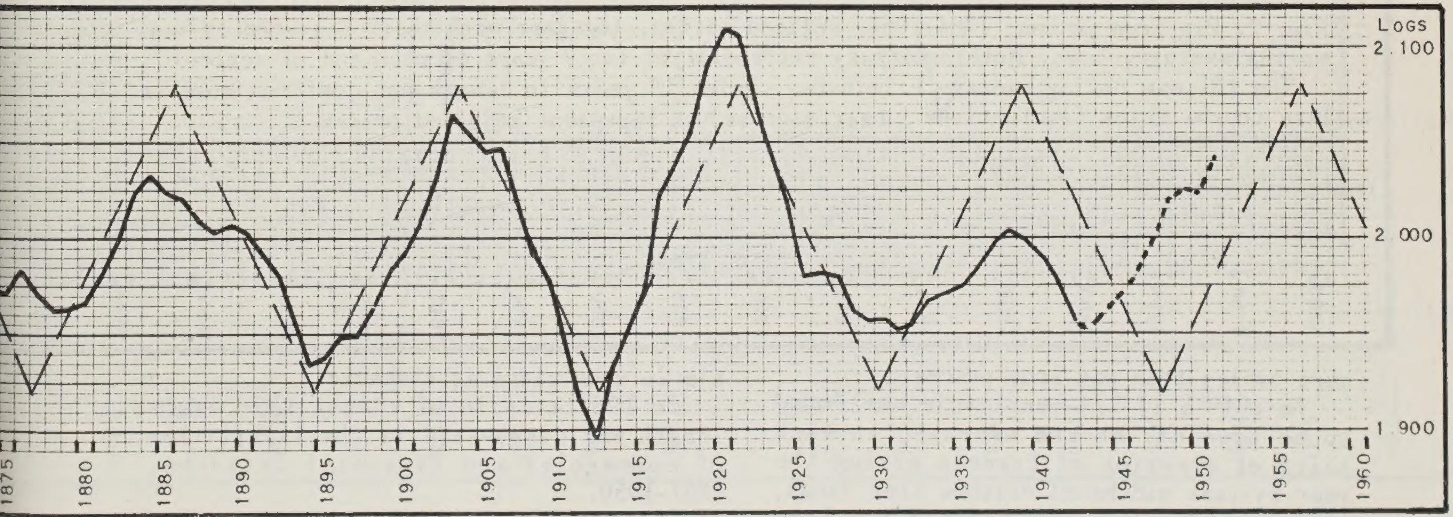


Fig. 6. Typical 17¾-year wave as found in the periodic table repeated in phantom, together with a 9-year moving average of the ideal wave, shown by means of a dotted line.



The last trough in the ideal cycle occurred at 1948.1 The next crest is due at 1957.0 (January 1, 1957)

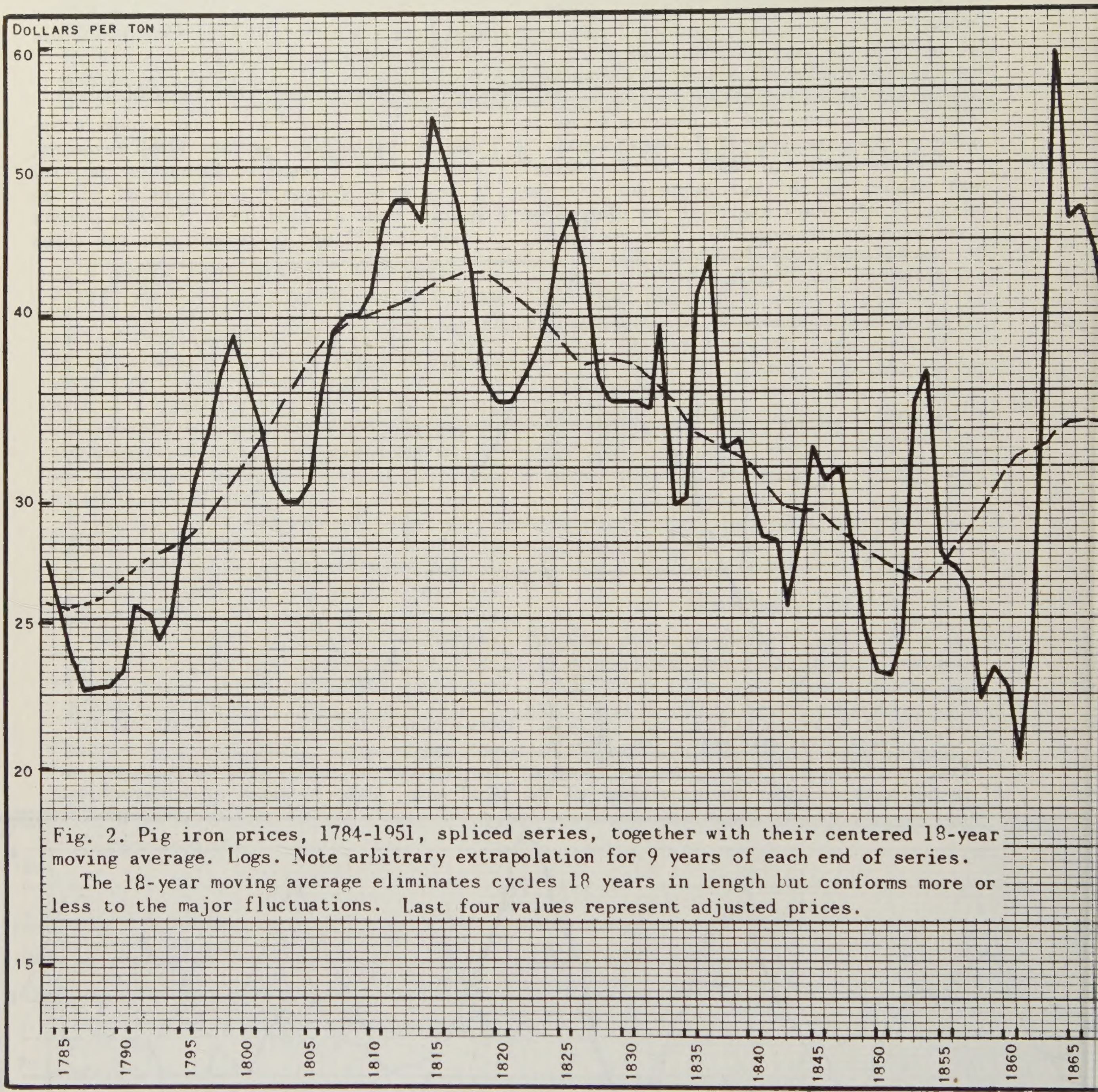


Fig. 2. Pig iron prices, 1784-1951, spliced series, together with their centered 18-year moving average. Logs. Note arbitrary extrapolation for 9 years of each end of series.

The 18-year moving average eliminates cycles 18 years in length but conforms more or less to the major fluctuations. Last four values represent adjusted prices.

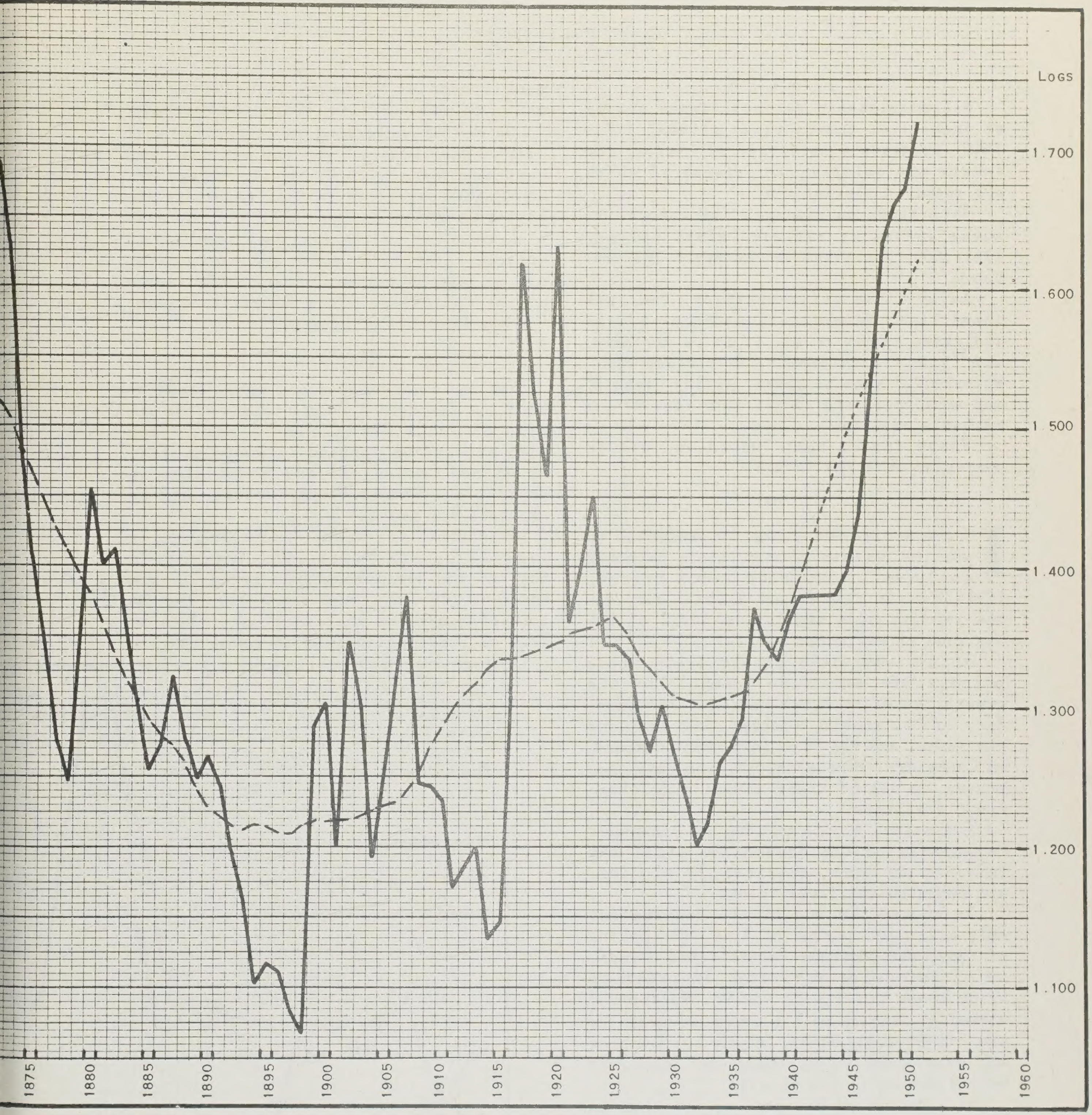
more cycles than pig iron prices.

In 1949 a 17 3/4-year cycle was found to be present, on the average, in each third of a series of figures giving the year-by-year widths of Arizona tree rings, 1100 to 1897. The work has not yet been done to make sure that the 17 3/4-year cycle in tree rings is rhythmic.

In 1951 a cycle of almost this exact length was discovered in the liabilities of commercial and financial failures, 1857-1950.

The 17 3/4-year cycle is seemingly of considerable importance.

erd


Logs
1.700
1.600
1.500
1.400
1.300
1.200
1.100
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960

POSSIBLE CYCLES IN INDUSTRIAL STOCK PRICES, 1871–1950

Summary

A comprehensive reconnaissance survey of industrial common stock prices, 1871-1950, suggests a multitude of cycles, the length and relative importance of which are shown in the article.

This study supplements the reconnaissance survey of railroad stock prices, 1831-1950, published in the April 1952 report.

As with the railroad study, the task ahead is to investigate each one of the indicated cycles to see if it is rhythmic, and if so, to determine its various characteristics such as shape, timing, length, and amplitude, and to get some idea of its probable reality.

Those cycles that "stand up" can be projected into the future.

IN the April 1952 report I presented to you the results of a multiple harmonic analysis of railroad stock prices, 1831-1950. In this report I shall give you the results of a similar analysis of industrial stock prices, 1871-1950.

This study, like the railroad stock price study, was made possible by the generosity of Stockham Valves & Fittings, Inc. of Birmingham, Alabama, who supplied the money, and the Mico Instrument Company, of Cambridge, Massachusetts, who gave free access to one of their latest model harmonic analyzers.

The actual work was done by Alexander Malinowski of the Foundation staff who laid out the work, operated the machine, and computed the final values.

As we had the use of the machine for only a limited period of time, the making of these periodograms necessitated a period of intensive activity. In order to bring these results to you Mr. Malinowski worked an average of 114 hours per week for the three weeks during which the machine was available. On at least two occasions he did not go to bed at all.

As a result of his zeal we are able to present to you a series of results which would have taken 6½ years work with paper, pencil, and an ordinary calculating machine such as a Friden, Monroe, or Marchant.

By way of background in connection with "mechanical brains" you may wish to read correspondence with Mr. R. I. Abbay, Jr. of Memphis reprinted in this report in the **Letters** section on page 188. You may also wish to refer to the railroad stock price article referred to above and to an article on page 54 of the Spring 1952 issue of the **Journal of Cycle Research** called, "A New Form of Periodogram."

The Data

For our industrial stock price study we used the Standard & Poor's Corporation series of Industrial Common Stock Prices (365 stocks) as carried backward to 1871 by Alfred Cowles III and Associates in their book, **Common Stock Indexes**, and as adjusted for trend.

We charted the actual index for you on page 87 of our March 1951 report. We charted the deviations from trend for you on pages 148 and 149 of the April 1951 report. We gave you the numerical values in logs of these deviations on pages 146 and

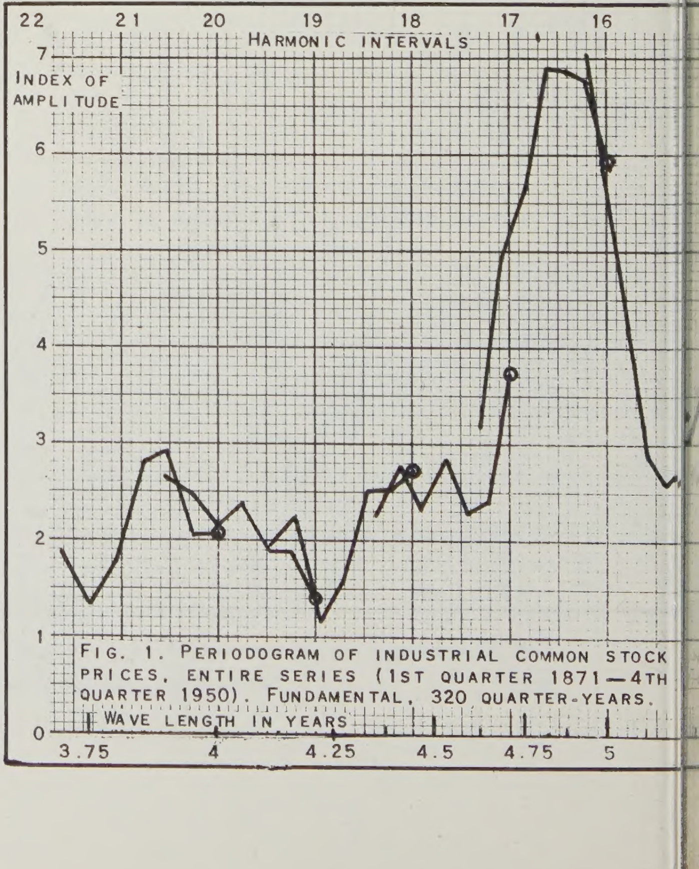
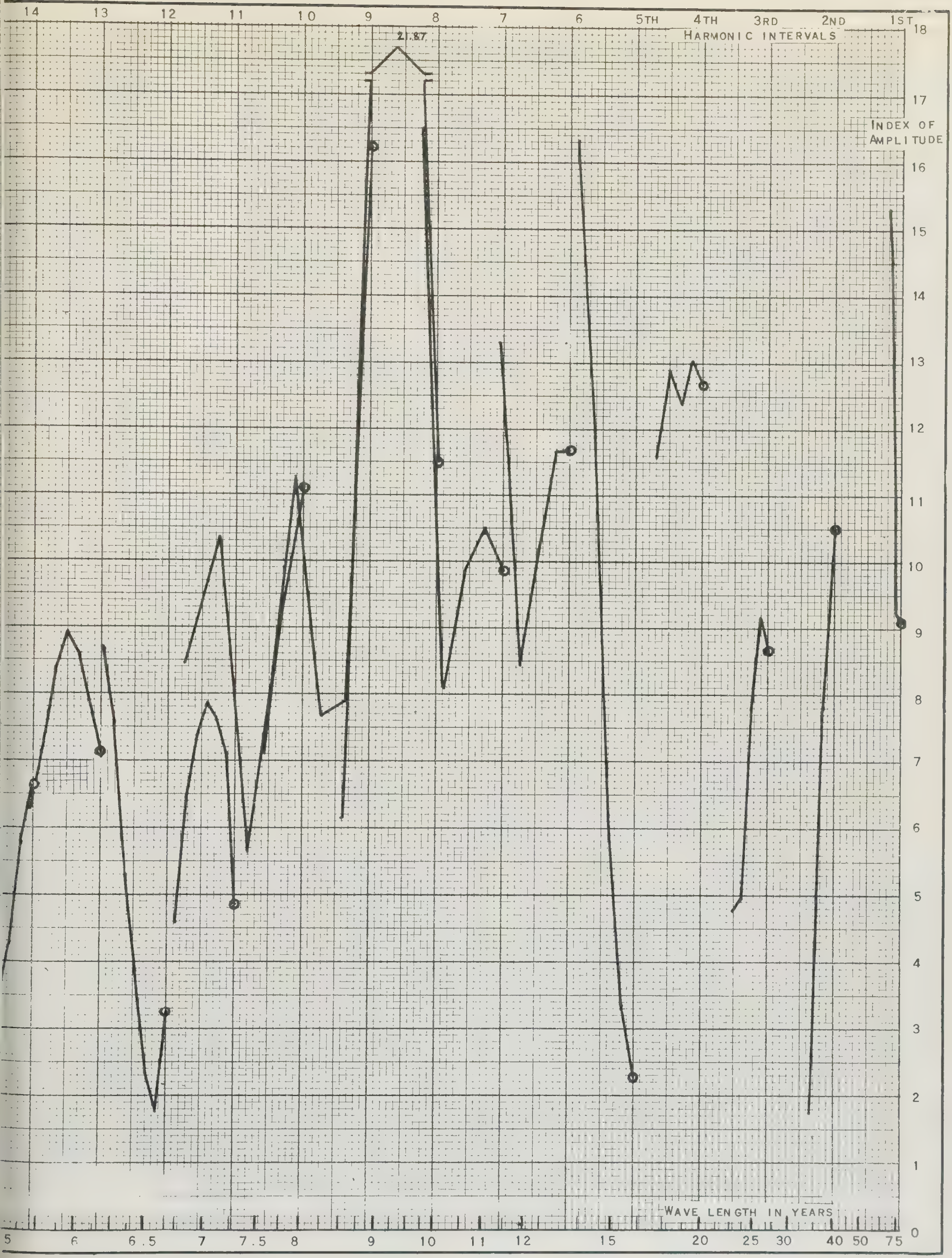


FIG. 1. PERIODOGRAM OF INDUSTRIAL COMMON STOCK PRICES, ENTIRE SERIES (1ST QUARTER 1871—4TH QUARTER 1950). FUNDAMENTAL, 320 QUARTER-YEARS.


14
13
12
11
10
9
8
7
6
5TH
4TH
3RD
2ND
1ST
HARMONIC INTERVALS
21.87
INDEX OF AMPLITUDE
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
WAVE LENGTH IN YEARS
5
6
6.5
7
7.5
8
9
10
11
12
15
20
25
30
40
50
75

147 of that same issue. On page 86 of the March 1951 issue we printed a chart to show you the dates when the stocks of the various industries were added to the index.

Scope of the Analysis

In making the multiple harmonic analysis of industrial common stock prices, we analyzed the entire series of 80 years or 960 months down to its 21st harmonic. That is, we scanned the series for cycles of all lengths from 80 years long down to $\frac{1}{21}$ of 80 years, or 45+ months long.

We then divided the series into three separate parts, each part 320 months long. We analyzed these three parts separately down to their 31st harmonic. This work gave us a reconnaissance of all cycles that might be present in each third of the series down to wave lengths $\frac{1}{31}$ of 320 months, or 10+ months.

Finally we divided the series into sixths, each sixth being 160 months long. We intended to analyze each one of the six segments down to its 31st harmonic (wave lengths of $\frac{1}{31}$ of 160 months, or 5+ months). Unfortunately time did not permit us to run through the machine any except the last two sections, namely, the 5th sixth, from May 1924 through August 1937, and the 6th sixth, from September 1937 through December 1950.

As you can see from the foregoing description, we made six different multiple analyses of industrial common stock prices—one analysis of the series as a whole, three of the series by thirds, and two of the last two parts of the series by sixths. This is the most intensive analysis of these prices ever made, as far as I know.

Six Periodograms Obtained

From these analyses we were able to construct six periodograms which are shown herewith as Figs. 1 to 6 inclusive.

A periodogram bears the same relationship to a forecast that a recipe bears to a piece of cake. A periodogram is a highly desirable prerequisite to cycle analysis, but it will not provide you with facts you can use directly. If all you want is final

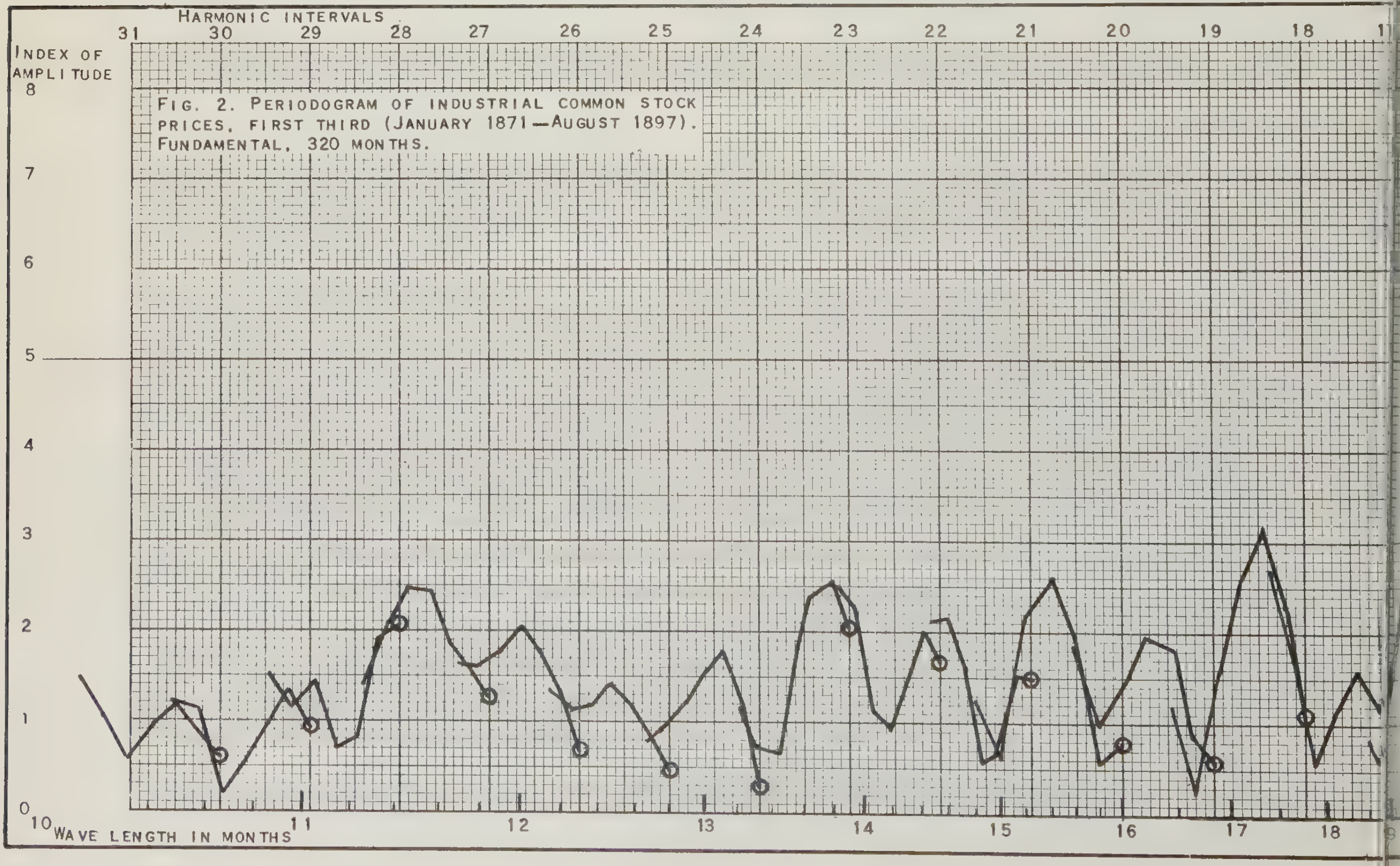


FIG. 2. PERIODOGRAM OF INDUSTRIAL COMMON STOCK PRICES, FIRST THIRD (JANUARY 1871—AUGUST 1897). FUNDAMENTAL, 320 MONTHS.

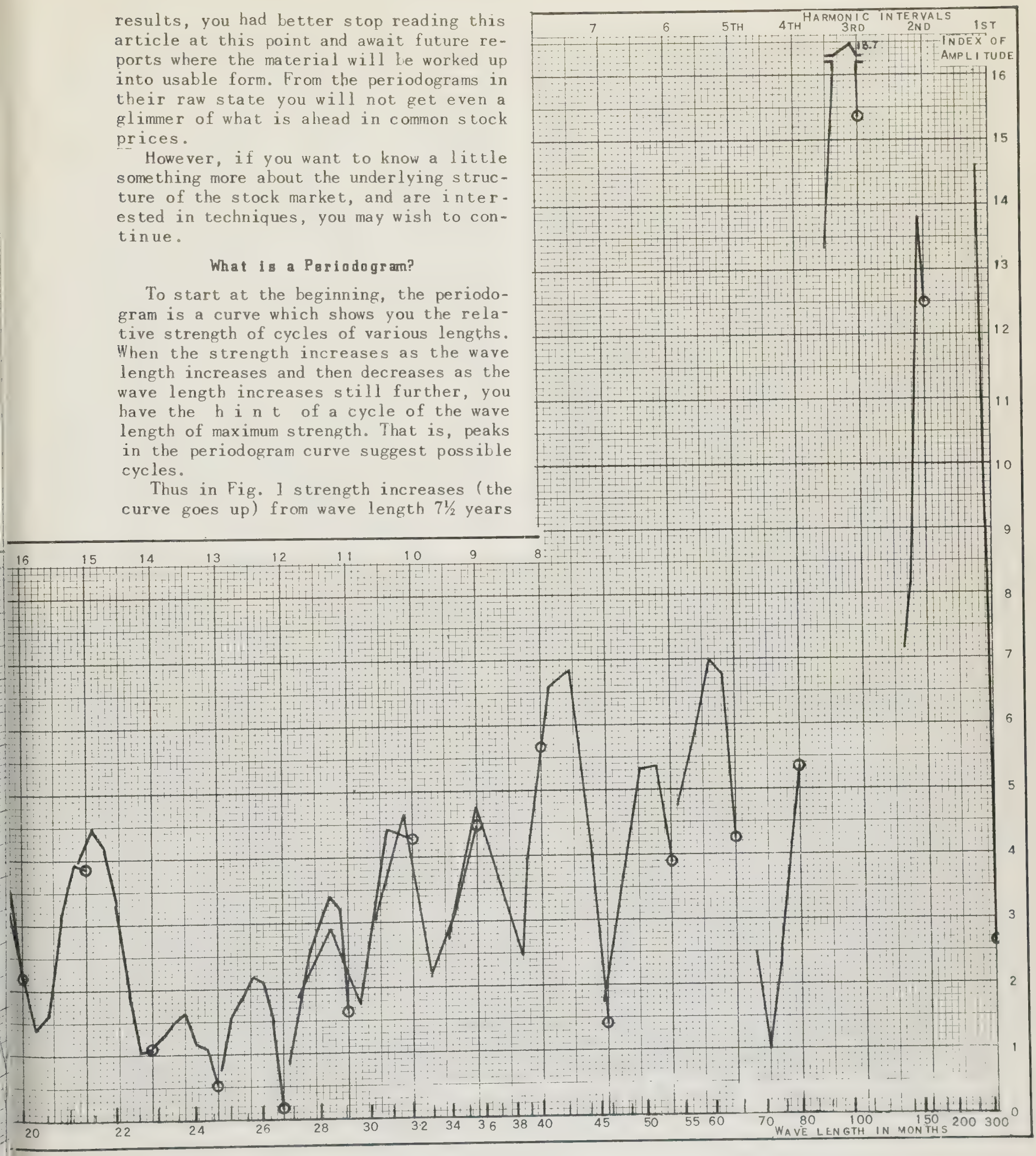
results, you had better stop reading this article at this point and await future reports where the material will be worked up into usable form. From the periodograms in their raw state you will not get even a glimmer of what is ahead in common stock prices.

However, if you want to know a little something more about the underlying structure of the stock market, and are interested in techniques, you may wish to continue.

What is a Periodogram?

To start at the beginning, the periodogram is a curve which shows you the relative strength of cycles of various lengths. When the strength increases as the wave length increases and then decreases as the wave length increases still further, you have the hint of a cycle of the wave length of maximum strength. That is, peaks in the periodogram curve suggest possible cycles.

Thus in Fig. 1 strength increases (the curve goes up) from wave length 7½ years



to wave length 8 years and then goes down again to wave length 8½ years. This means that there may be a cycle at wave length 8 years (read from the bottom scale) with a strength of about 11 (read from the side scale). As we go still further to the right the curve goes up again to about wave length 9¼ and then down again to 10. This indicates that there may be a cycle with a wave length of about 9¼ years with strength or amplitude of about 22,—twice as strong as the cycle with a wave length of 8 years.

Scales Used

The vertical scale is easy to understand. However, if you notice carefully you will see that the wave lengths on the horizontal scale get closer and closer together as you go toward the right. For example, in Fig. 1, wave lengths of 20 years and 40 years are separated by no more horizontal space than are wave lengths of 8 years and 10 years. This is so because I have used a harmonic horizontal scale. A harmonic horizontal scale should always be used for periodograms.

In a harmonic scale equal horizontal distances represent equal harmonics or unit fractions of the total length of the series being analyzed. Thus in Fig. 1, as the series being analyzed is 80 years long (1871-1950), the harmonics are—

1st harmonic (fundamental),	80 years	
2nd harmonic,	40 years	(½ of 80 years)
3rd harmonic,	26.6 years	($\frac{1}{3}$ of 80 years)
4th harmonic,	20 years	(¼ of 80 years)
5th harmonic,	16 years	($\frac{1}{5}$ of 80 years)

And so on.

It is these harmonics or unit fraction lengths that are represented by the heavy vertical lines, starting with the first harmonic at the right and running to the 31st harmonic at the left. The harmonic scale is shown, running from right to left, at the top of the periodogram.

At this point I would like to introduce the idea of fractional harmonics. In Fig. 1, if the 3rd harmonic represents $\frac{1}{3}$ of 80 years and the 4th harmonic represents ¼ of 80 years the location $\frac{1}{10}$ of the way from the 3rd harmonic to the 4th harmonic would logically represent $\frac{1}{3.1}$ of 80 years or 25.8 years. If you look at Fig. 1 you will find a hint of a cycle at

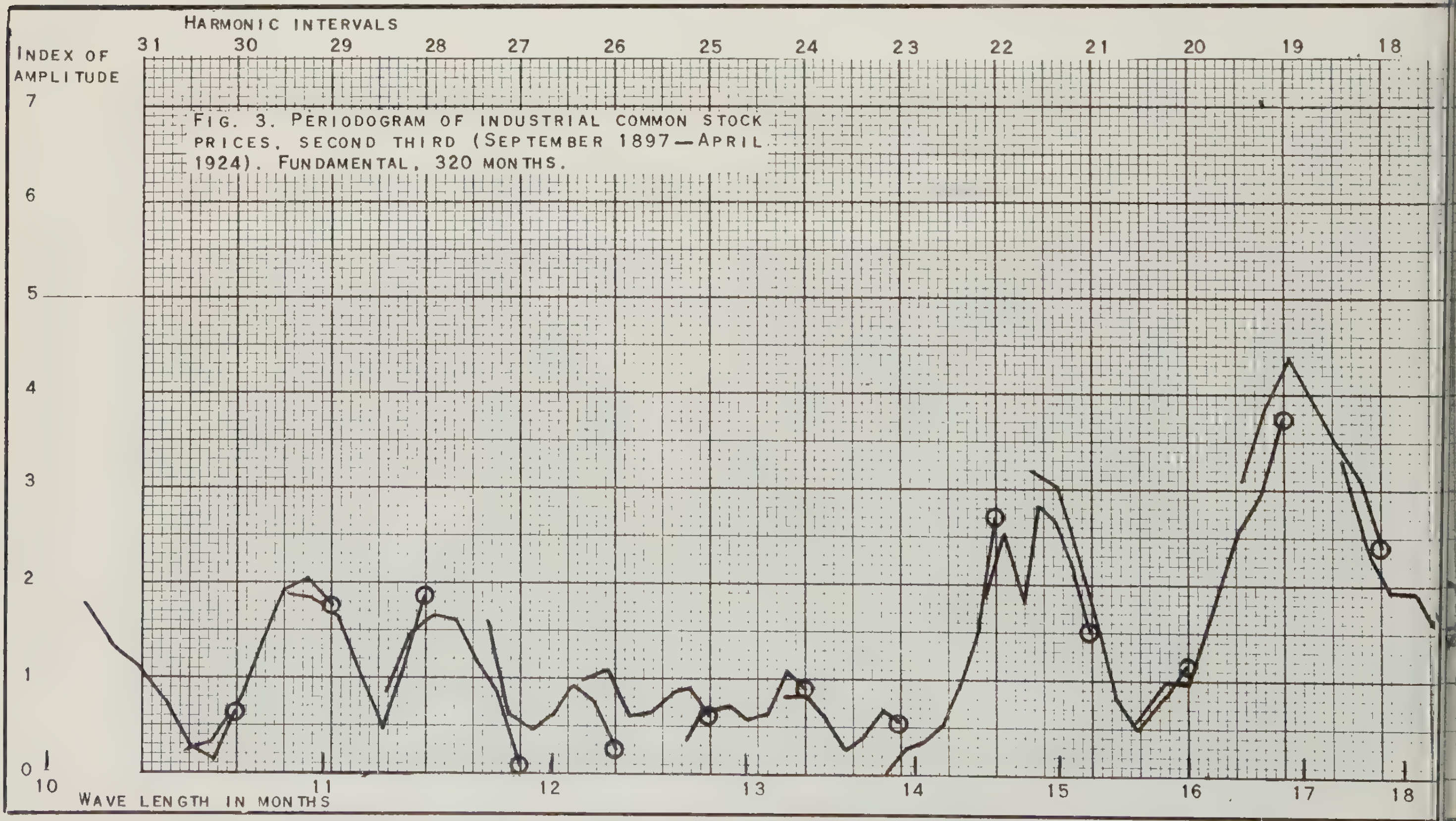


FIG. 3. PERIODOGRAM OF INDUSTRIAL COMMON STOCK PRICES, SECOND THIRD (SEPTEMBER 1897—APRIL 1924). FUNDAMENTAL, 320 MONTHS.

about this length.

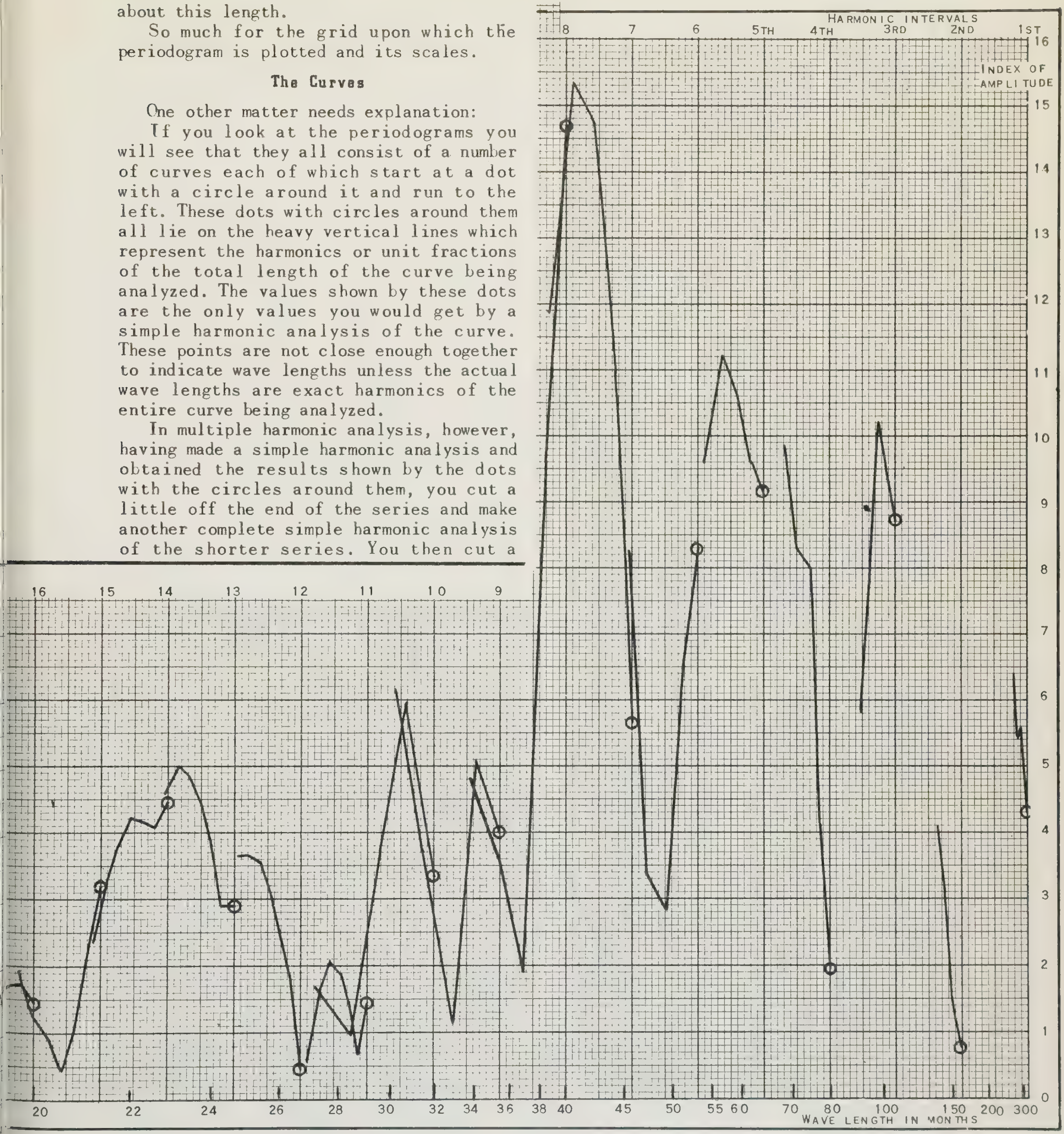
So much for the grid upon which the periodogram is plotted and its scales.

The Curves

One other matter needs explanation:

If you look at the periodograms you will see that they all consist of a number of curves each of which start at a dot with a circle around it and run to the left. These dots with circles around them all lie on the heavy vertical lines which represent the harmonics or unit fractions of the total length of the curve being analyzed. The values shown by these dots are the only values you would get by a simple harmonic analysis of the curve. These points are not close enough together to indicate wave lengths unless the actual wave lengths are exact harmonics of the entire curve being analyzed.

In multiple harmonic analysis, however, having made a simple harmonic analysis and obtained the results shown by the dots with the circles around them, you cut a little off the end of the series and make another complete simple harmonic analysis of the shorter series. You then cut a



little more off the series and do it again, time after time, until you get all the points you want.

In the periodogram of the multiple harmonic analysis of railroad stock prices I showed you all these values by means of vertical horizontal lines. In the periodograms printed herewith, charting the results of the multiple harmonic analysis of industrial stock prices, I am showing you the results by points, connected to each other.

The points are not all connected. We connected only the points representing the same harmonic. Thus, in analyzing the entire series (Fig. 1) when we came to the 12th harmonic we found the strength of the average cycle $\frac{1}{12}$ of the entire series long ($\frac{80}{12}$ or 6.6 years) to be 3.25. This value was plotted as a point with a circle around it. Then we cut about a year off the end of the series and found the 12th harmonic of the slightly shorter series; and so on six times to get six more points. It is these seven points which are connected.

By the time we had cut six sections off the original curve we had reduced its length about six years so that $\frac{1}{12}$ of the abated length was just about as long as $\frac{1}{13}$ of the original length.

Therefore on the line representing the 13th harmonic of the original series ($\frac{80}{13}$ or 6.2 years long) you had two points: one with an amplitude or strength of 8.7 representing the 12 harmonic of 80 years, the other at amplitude 7.1 representing the strength of the 13th harmonic of 73.8 years.

Reasons for Discontinuity

As the 12th harmonic of 73.8 is 6.2 years long and the 13th harmonic of 80 is 6.2 years long they both represent waves of identical length. Why, then, do we not get the same strength or amplitude?

Ideally we should, but there are two sources of error that have crept into the work which you should know about and be forewarned against. First, in the two analyses we are not dealing with the same data. Six more years of data in the longer curve can materially alter the picture. Second, a harmonic analysis should deal with data that has been fully corrected for trend. That is, the curve should end at the same value as the value at which it starts. In multiple harmonic analysis this is not always feasible. An error is introduced for this reason also.

Sources of Error

On the other hand, these errors are not usually too important, because there are two other errors inherent in harmonic analysis which are usually even worse.

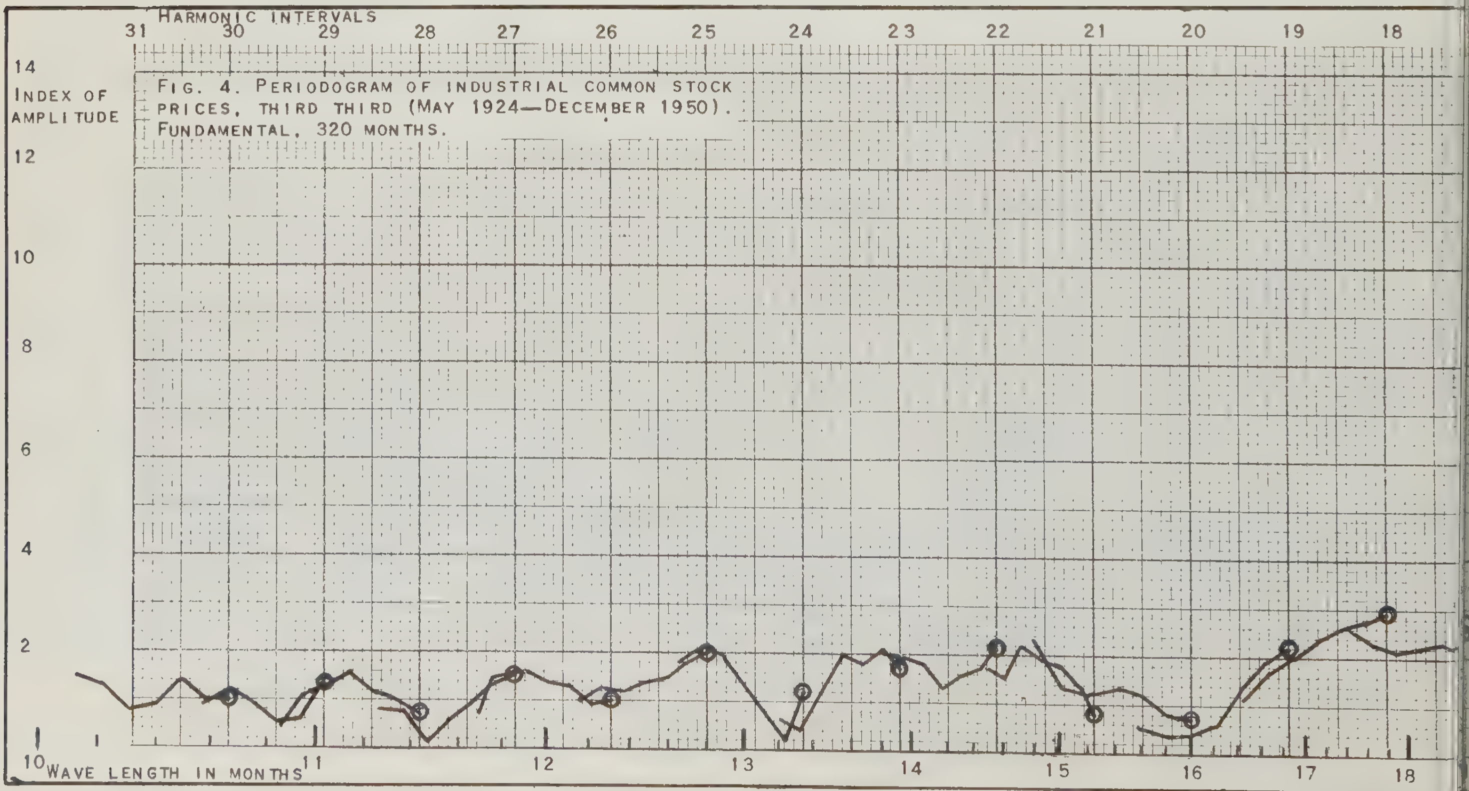
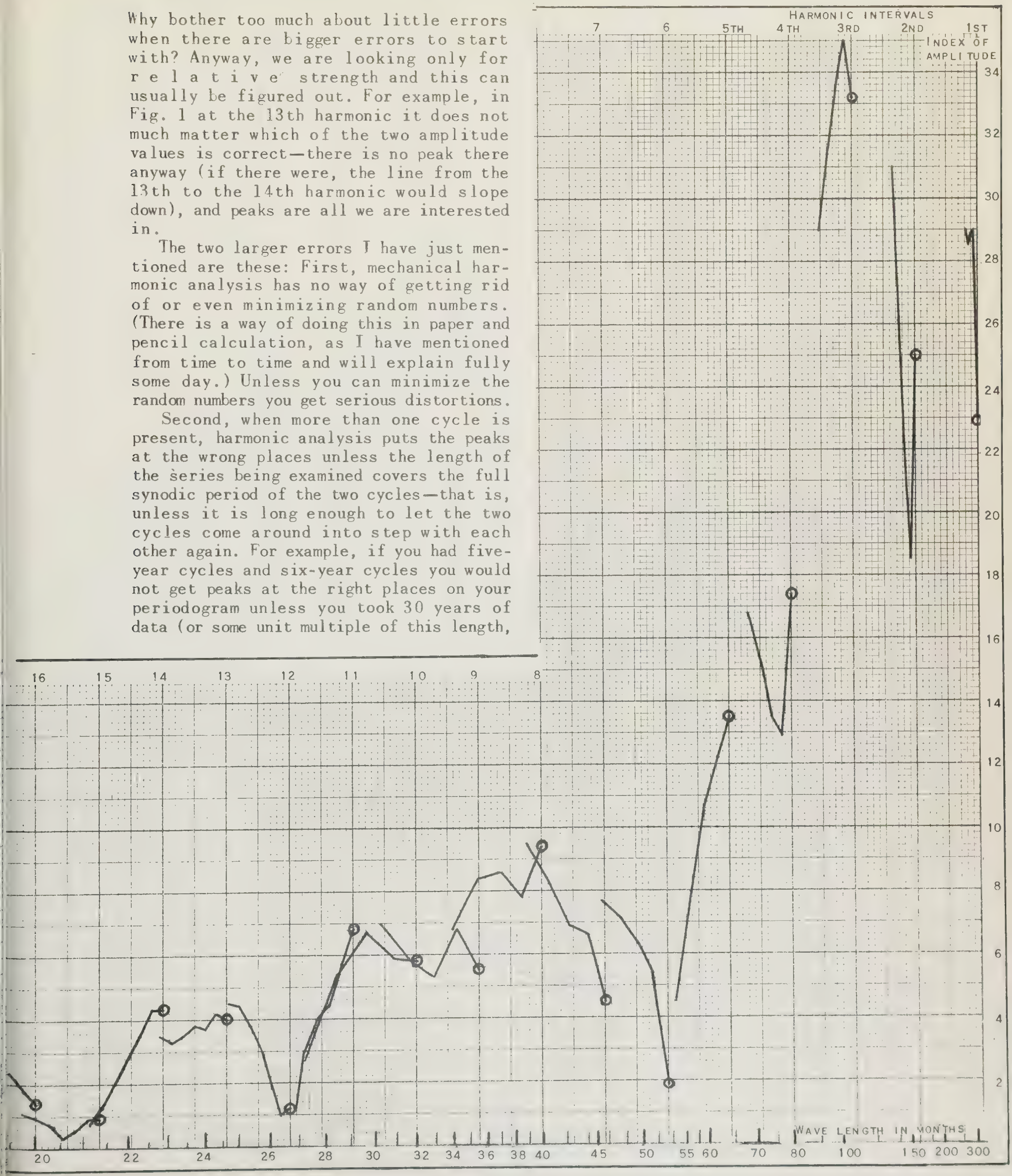


Fig. 4. Periodogram of industrial common stock prices, third third (May 1924—December 1950). Fundamental, 320 months.

Why bother too much about little errors when there are bigger errors to start with? Anyway, we are looking only for relative strength and this can usually be figured out. For example, in Fig. 1 at the 13th harmonic it does not much matter which of the two amplitude values is correct—there is no peak there anyway (if there were, the line from the 13th to the 14th harmonic would slope down), and peaks are all we are interested in.

The two larger errors I have just mentioned are these: First, mechanical harmonic analysis has no way of getting rid of or even minimizing random numbers. (There is a way of doing this in paper and pencil calculation, as I have mentioned from time to time and will explain fully some day.) Unless you can minimize the random numbers you get serious distortions.

Second, when more than one cycle is present, harmonic analysis puts the peaks at the wrong places unless the length of the series being examined covers the full synodic period of the two cycles—that is, unless it is long enough to let the two cycles come around into step with each other again. For example, if you had five-year cycles and six-year cycles you would not get peaks at the right places on your periodogram unless you took 30 years of data (or some unit multiple of this length,



such as 60 years or 90 years). If you took some other length of data, such as 13 years or 45 years you would get your peaks moved a bit one way or the other—and perhaps quite a bit. (In this connection, refer to "Limitations of the Periodogram," an article printed in our report for June 1951.) In view of this fact, and the utter impossibility of using enough data to give you the synodic period of all the different cycles, you are going to get errors from this source too. That is why the two other errors I spoke of at first do not loom too importantly.

Finally, there are errors of interpretation of the periodogram which arises in actual practice because you do not have enough points between harmonics. For example, in Fig. 1 we have placed an arrow at the 6.1 harmonic ($\frac{1}{10}$ of a harmonic interval to the left of the numeral six at the top of the chart). This means that we guessed that the curve might go up between the 6th harmonic and the 6.2 harmonic, cresting perhaps at 6.1. It is a guess that seems reasonable and can be rather easily justified. My own private unjustifiable hunch, however, is that the peak really lies between 6.2 and 6.5, that it is on its way down at 6.2, and is coming up again at 6.0 toward a second peak at 5.9 (all numerals referring to the harmonic scale at the top of the page), and that 6.1 probably represents a low spot instead of a peak.

Periodograms Give Merely Hints

For all these reasons you must consider the peaks of the periodograms merely as hints of cycles which may possibly be present in the series. You must go on from there.

Two other points need to be discussed: First, why are there gaps with no coverage at the right of the periodograms and overlaps with double coverage in the left section? Second, when we break the curve into sections, as the 1st, 2nd, and 3rd thirds, why are the various sections not consistent with each other? Why, for example, do we find a cycle about 23 months in the section from 1950 back to 1924 and from 1924 back to 1897, but not in the section 1897 back to 1871?

Why Are There Gaps in the Periodogram Curve?

To answer the first question first, there are gaps and overlaps because the machine computes values for five harmonics at a clip. The particular machine we worked with computed five even harmonics or five odd harmonics. That is, it would run the 1st, 3rd, 5th, 7th, and 9th harmonics at one time, the 2nd, 4th, 6th, 8th, and 10th harmonics, the next time, then the 11th, 13th, 15th, 17th, and 19th harmonics, and so on.

Now suppose that, as in Fig. 1, you decide that you will make a total of seven runs for each harmonic as we discussed above, chopping off sections of the curve so that the 19th harmonic of the shortest

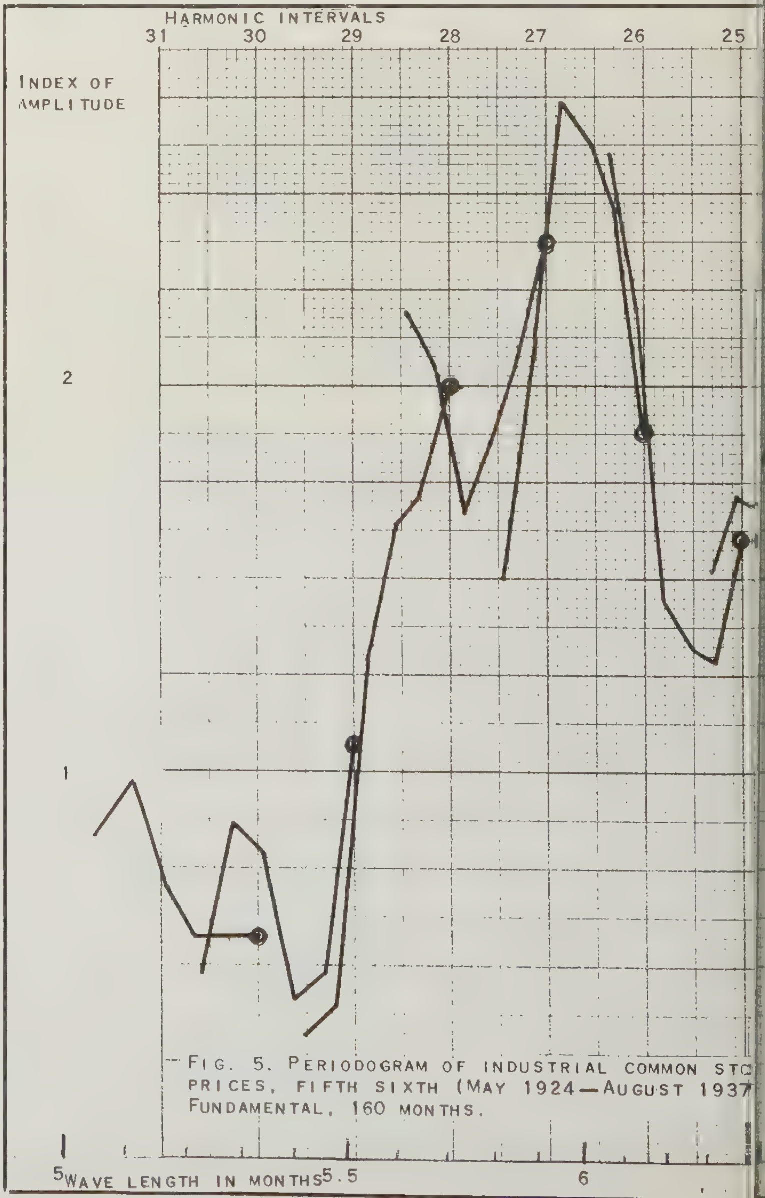
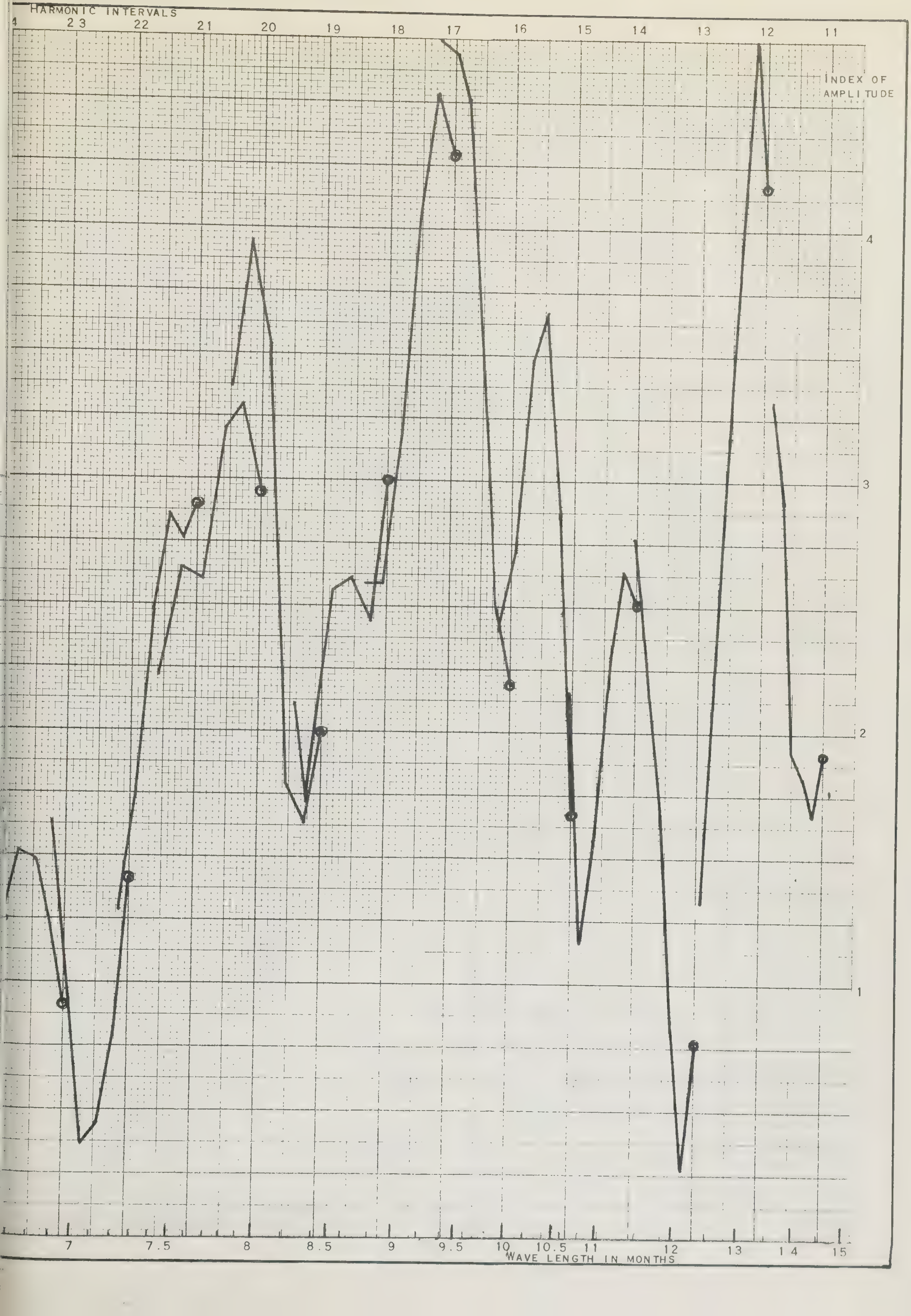


FIG. 5. PERIODOGRAM OF INDUSTRIAL COMMON STC PRICES, FIFTH SIXTH (MAY 1924—AUGUST 1937 FUNDAMENTAL, 160 MONTHS.


HARMONIC INTERVALS
4
23
22
21
20
19
18
17
16
15
14
13
12
11
INDEX OF AMPLITUDE
4
3
2
1
7
7.5
8
8.5
9
9.5
10
10.5
11
12
13
14
15
WAVE LENGTH IN MONTHS

section will just exactly equal the 20th harmonic of the entire series. That is easy to compute. The 20th harmonic of 80 years is 4 years $(\frac{80}{20})$. The 19th harmonic of 76 years is 4 years. The two points will coincide. The 12th harmonic of 80 years is $\frac{80}{12}$ or 6.6, and the 11th harmonic of 76 years is only 6.9 years. We will, therefore, have no coverage between 6.6 years and 6.9 years.

If we chop more off the original 80 year series we can get the 11th harmonic to come out right, and equal the 12th harmonic of 80 years, but then the 19th harmonic of the shorter length will overlap not only the 20th harmonic but all values almost to the 21st harmonic as well.

This being the nature of harmonics there is nothing you can do about it except to choose some middle ground. This works out pretty well except for the first few harmonics, say from the 1st to the 6th. In such cases, we scanted the shorter harmonics because the longer cycles involved have no chance to repeat themselves many times anyway, and therefore, although they may be perfectly real, one can have no good internal evidence of that fact.

Why Do the Different Sections of the Periodogram Show Different Results?

This brings us to the final point of this article. Why do you not find the same cycles in each of the different shorter sections as in the entire series? Why do you not find the same cycles in one short section as in another?

There are many reasons why it could be so. Perhaps in some instances it is one reason, perhaps in another instance it is another.

Here are some of the possible explanations:

1. The peak in the periodogram could reveal merely some grouping of large accidental distortions.
2. The cycle might actually be present as a rhythmic cycle in part of the curve, but might be present as a result of random forces just happening to come at rhythmic intervals (see article called "Cycles in Random Numbers," in our January 1952 report).
3. The cycle may have changed its length over the period of time.
4. The periodogram indications may be wrong.
5. We may be dealing with a compound cycle, the two parts of which largely offset each other in the section of the curve where it did not appear.
6. The cycle may be a characteristic of some particular part of the composite which was not present throughout the series. For example, if the 23-month cycle spoken of above was present from 1897 on, but not from 1871 to 1897, it might mean that this cycle is not present in shipbuilding, mining, iron and steel and other sorts of stocks in the index prior to 1897, but is present in textile, fertilizer, tobacco, or other sorts of stocks which were added to the index at the turn of the century.

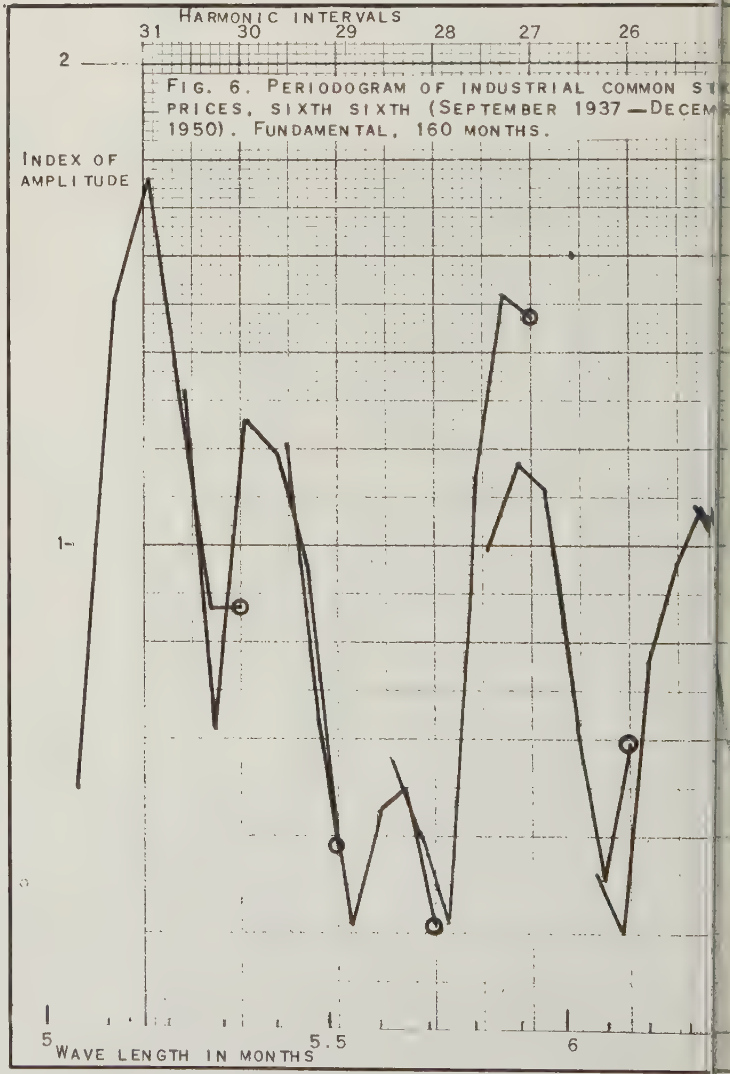


Fig. 6. Periodogram of Industrial Common St prices, sixth sixth (September 1937 — Decem 1950). Fundamental, 160 months.

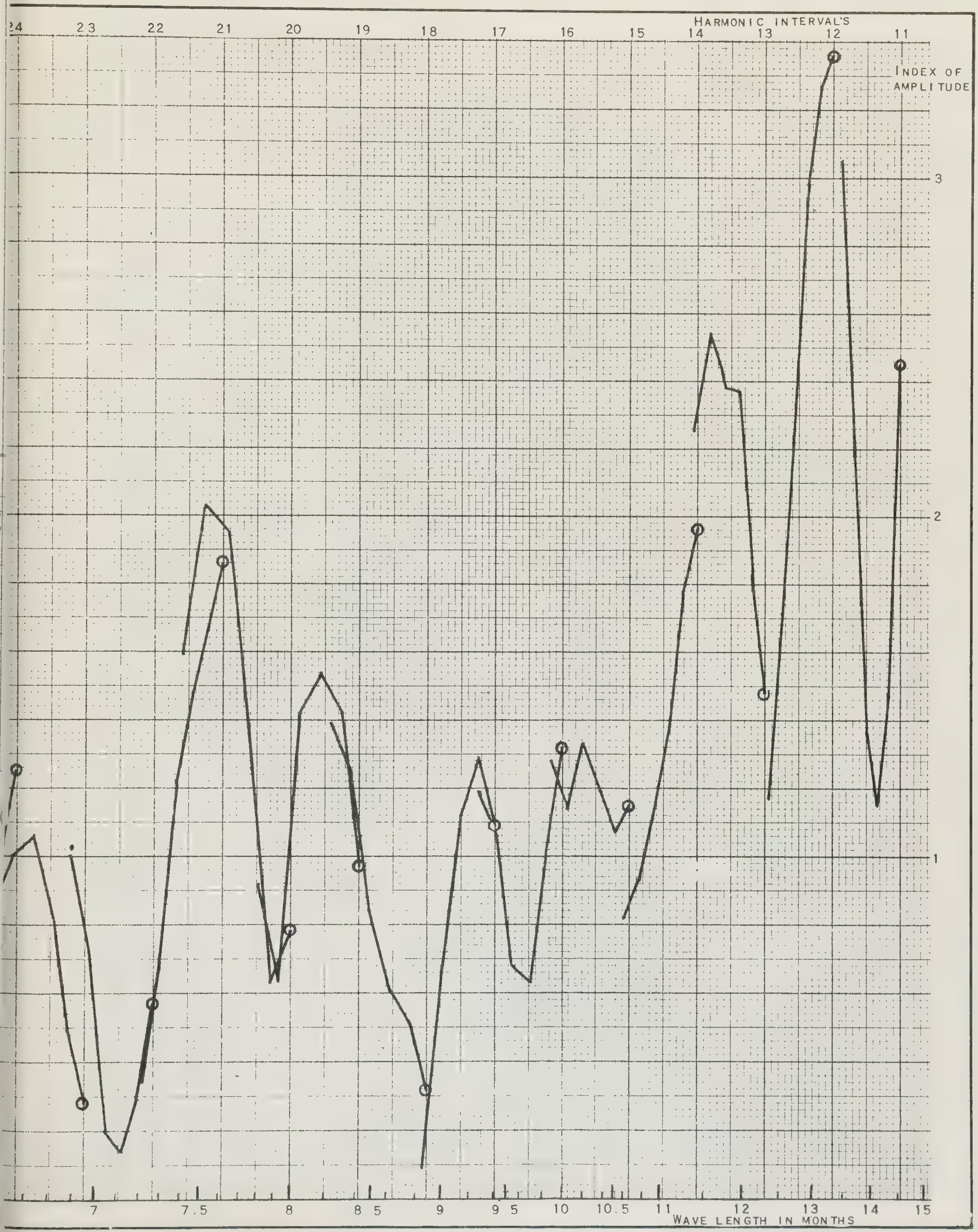

HARMONIC INTERVAL'S
24
23
22
21
20
19
18
17
16
15
14
13
12
11
INDEX OF AMPLITUDE
3
2
1
7
7.5
8
8.5
9
9.5
10
10.5
11
12
13
14
15
WAVE LENGTH IN MONTHS

Table 1 Gives Wave Lengths

This brings us now to Table 1 which shows the wave lengths in industrial common stock prices suggested by the six periodograms and, for comparison, the wave lengths suggested by the periodogram of railroad stock prices, 1831-1950, as reported upon in our April report.

Table 1 does not show the strength or amplitude of the various cycles. If you wish this information you can read it from the periodogram concerned. In connection with this matter or strength, remember that if two cycles fall within a harmonic interval of each other they supplement each other's amplitude. Thus, if you have two cycles with amplitude of four with lengths half of a harmonic interval apart they do not both have an amplitude of four. In fact, neither one of them has an amplitude of four. The real amplitude of one adds to part of the real amplitude of the other to give an apparent amplitude of four.

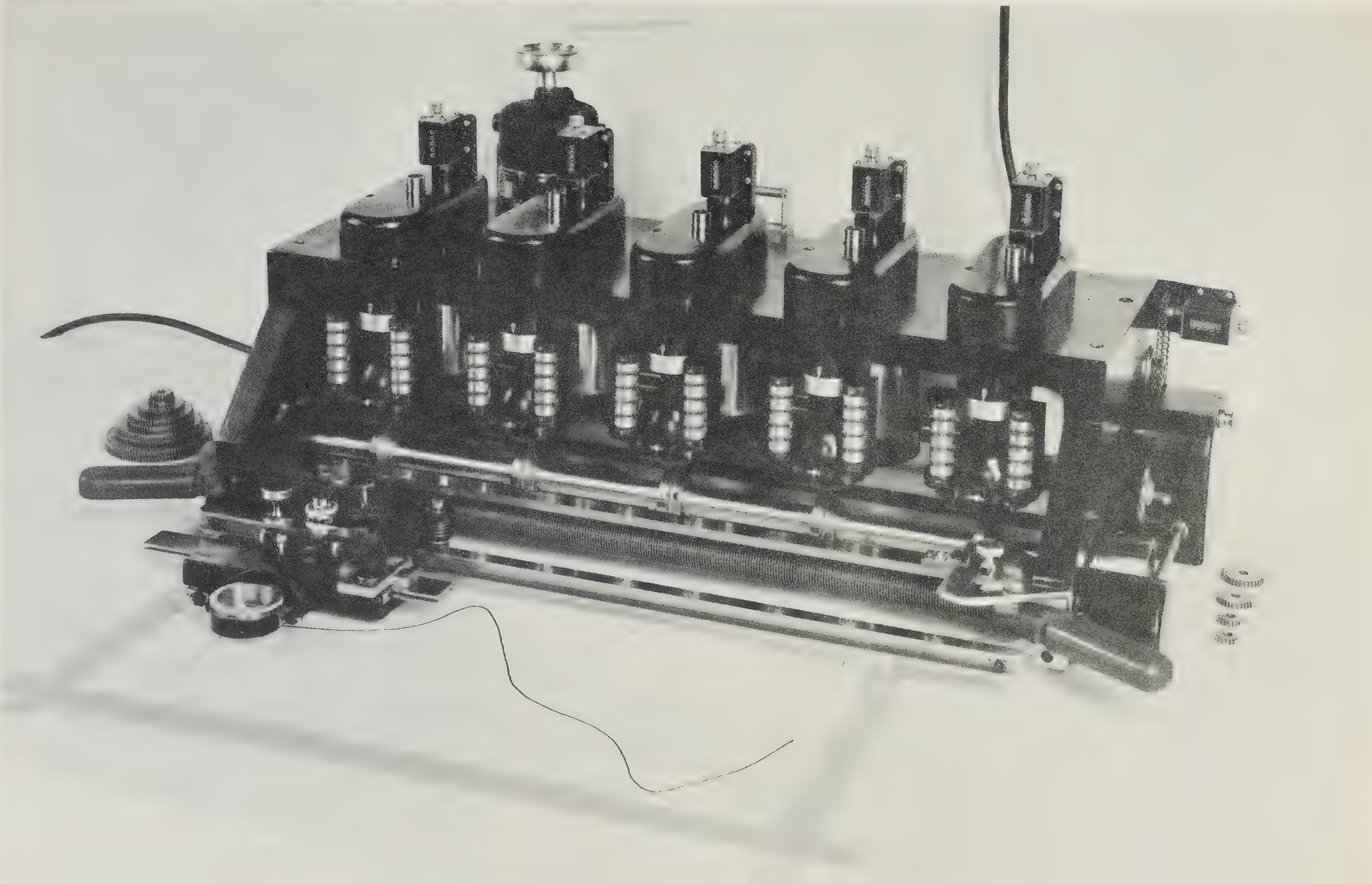
I am sorry this article has had to be so long and so technical. Unless you are a serious student I hope you skipped it! When, in future reports, we go on from here to discuss the various cycles suggested and to project them into the future, it will be more interesting.

erd

TABLE 1.

CYCLE LENGTH SUGGESTED BY PERIODOGRAMS

Industrial Stock Prices						Railroad Stock Prices
Entire Series Mo.	First Third Mo.	Second Third Mo.	Third Third Mo.	Fifth Sixth Mo.	Sixth Sixth Mo.	Entire Series Mo.
				5.1	5.1	
				5.3	5.3	
				5.6	5.6	
					5.8	
				6.0	5.9	
				6.4	6.3	
				6.5		
				6.8	6 7	
				7.5	7 6	
				7.8		
				8.0	8.1	
				8.5	8.3	
				9.2	9.2	
					9.3	
					9.9	
	10.6		10.5	10.3	10.2	
	10.8	10.9	10 7			
	11.1		11.1	11.2		
	11.5	11.5		11.4	11.6	
	12.0	12.1	11.9		11.9	
	12.5	12.6				
		12.9	12.8			
	13.1	13.2	13.6	13.1	13.3	
	13.7	13.9	13.8			
	14.4	14.5	14.5			
	14.6	14.9	14.7			
	15.3		15.5			
	16 4	16.8				
	17.3		17.8			
	18.3	18.7	18.7			
	19.6	19.6				
	21.6					
		22.2	22.7			
	23.7	23.2	23.7			
			24.3			
		24.9	24.9			
	25.8					
		27.8				
	28.6		29.1			
		30.5	30.2			
	31 2					
		34.2	34.2			
	35.6		36.2			
			39.0			
	41.6	41.6				
			43.0			
46.6			46.7			47.0
48.6						49.0
Yrs.	Yrs.	Yrs	Yrs.	Yrs.	Yrs.	Yrs.
4.2	4.2		4.2			4.2
4.3						
4.4						4.4
4.5						4.5
						4.6
4.8		4.8				4.8
4.9						5.0
						5.1
5.3						5.3
5.4						5.4
						5.5
			5.7			5.6
						5 9
6 0		6 1				6 1
						6 5
						6.6
7.0						7.0
						7 2
						7.8
7.9						7.9
	8 5	8.2	8.5			8.3
9.3						9.2
10.8			10 7			10 3
11.3						11 3
	12.7					
13.1						13.3
13.6						
						15.8
17.8						
19.1						19.3
		24 2	24.2			24.0
25.8						26.1
						31.6
						54.6
						100.0



Harmonic Analyzer

This is a picture of the machine we used to make the multiple harmonic analyses. The results of this analysis are shown on the preceeding pages. The machine was made by the Mico Instrument Company of Cambridge, Massachusetts.

THE 9.6-YEAR CYCLE OF GAME ABUNDANCE

ANOTHER 9.6-year wave of wildlife abundance seems to have been completed, according to a paper by R. M. Ferrie called "Upland Game in Western Canada."

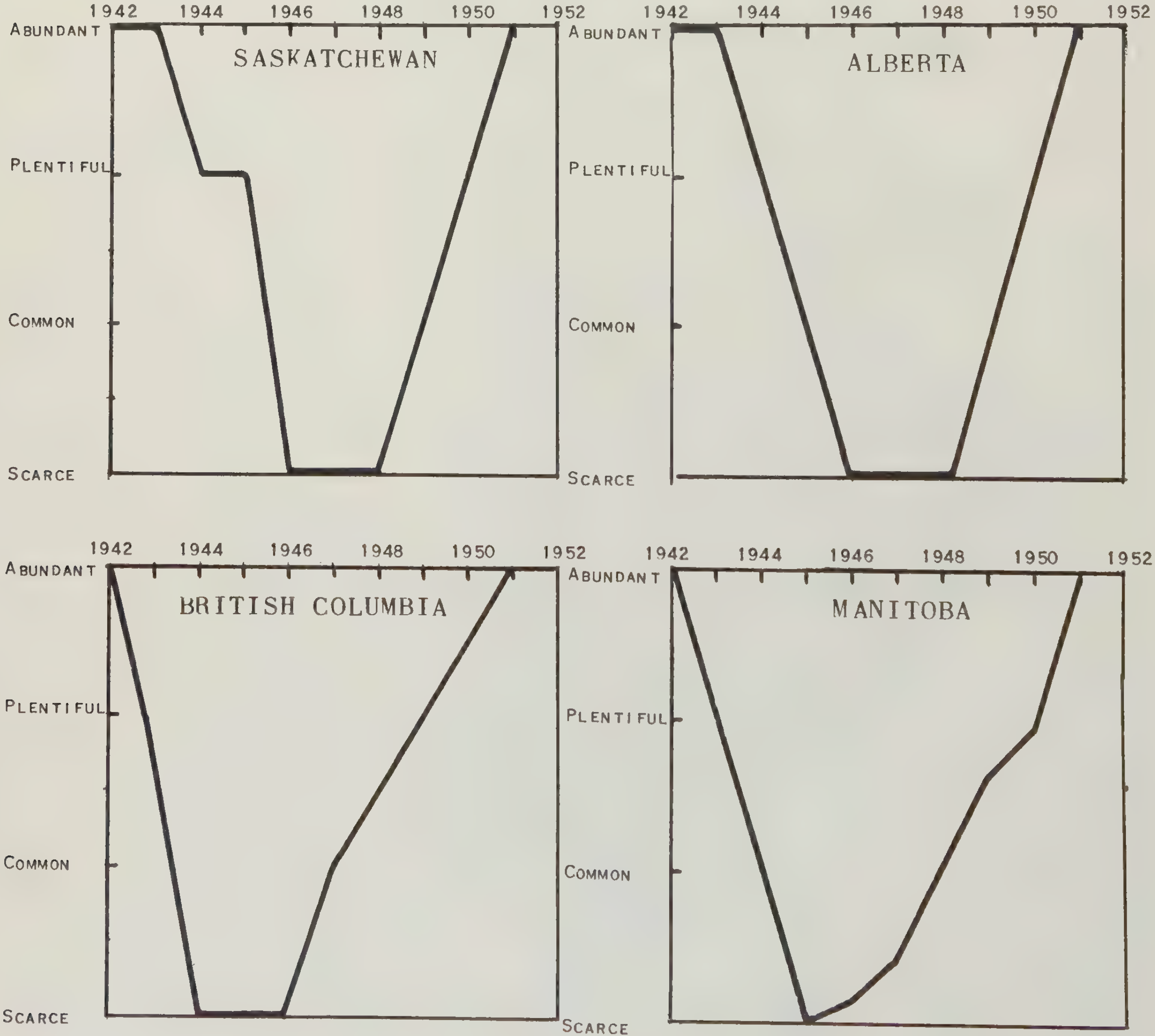
This paper, "based on facts received throughout Western Canada and offered as an educational service for sportsmen," is probably available free on request while the supply lasts. Address Saskatchawan Fish and Game League, No. Battleford, Saskatchawan, Canada.

After examining available facts the report concludes that it is not good conservation to close ruffed grouse and other hunting seasons during periods of low populations. The conclusion is based largely upon experiments of the Michigan Conservation Department. In Michigan, with no closed season on ruffed grouse during cyclic low, recovery was just as good as in Minnesota and Wisconsin where the seasons had been closed during this period.

Four of Mr. Ferrie's charts of game abundance are reproduced herewith.

As Ferrie says in the text "nature in her inimitable manner is poised again to deplete the ranks of our grouse and partridge and nothing that we know of is of any value in an attempt to halt the decline."

erd



Game Abundance 1942-1951

THE 14-DAY CYCLE IN THE AMOROUSNESS OF WOMEN

DID you know that women have a 14-day cycle of amorousness? Well they do. This fact was first recorded, as far as I know, by Dr. Marie C. Stopes in her book, **Married Love**, published in 1939 by G. P. Putnam's Sons of New York.

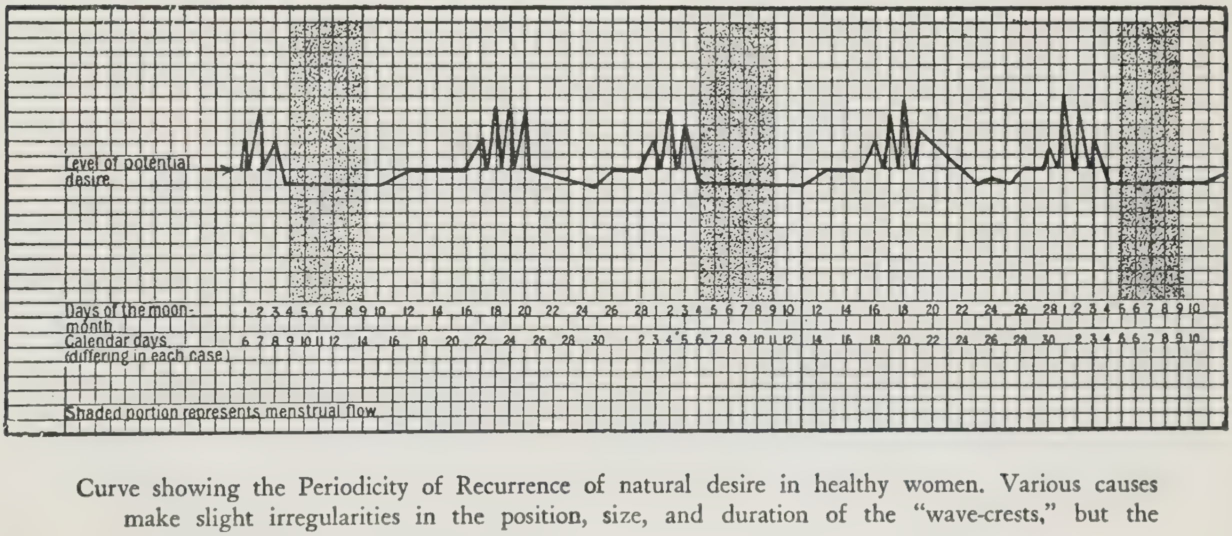
Instead of trying to tell you about this cycle myself, I think it would be better to quote directly from Dr. Stopes book,* which I am able to do through the courtesy of the publisher. Dr. Stopes said:

"By the majority of 'nice' people woman is supposed to have no spontaneous sex-impulses....Yet many, many women have shown me the truth of their natures when I have simply and naturally assumed that of course they feel it—being normal women—and have asked them only: When? From their replies I have collected facts which are sufficient to overturn many ready-made theories about women....

A 14-day Cycle Reported

"....I have found that wives (particularly happy wives whose feelings are not complicated by the stimulus of another love) who have been separated from their husbands for some months through professional or business duties—whose husbands, for instance, are abroad—are the women from whom the best and most definite evidence of a fundamental rhythm of feeling can be obtained. Such women, yearning daily for the tender comradeship and nearness of their husbands, find in addition at particular times, an accession of longing for the close physical union of the final sex-act. Many such separated wives feel this; and those I have asked to keep notes of the dates, have, with remarkably unanimity, told me that these times came specially just before and some a week or so after the close of menstruation, coming, that is, about every fortnight. It is from such women that I got the first clew to the knowledge of what I call the law of Periodicity of Recurrence of desire in women. For some years I have been making as scientific and detailed a study as possible of this extremely complex problem. Owing to the frank and scientific attitude of a number of women, and the ready and intimate confidence of many more, I have obtained a number of most interesting facts from which I think it is already

Chart I.



Curve showing the Periodicity of Recurrence of natural desire in healthy women. Various causes make slight irregularities in the position, size, and duration of the "wave-crests," but the general rhythmic sequence is apparent.

---

* From **Married Love**, by Dr. Marie C. Stopes. Copyright, 1931, 1939, by Marie Carmichael Stopes. Courtesy of G. P. Putnam's Sons.

possible to deduce a generalization which is illuminating, and may be of great medical and sociological value. As may be imagined, since this book was first published a great deal of further evidence has been sent to me: this remarkably confirms the original charts, so that I see no reason to revise the general statement for the average healthy type of woman. A more detailed and scientific consideration of my data will be published elsewhere.

The Law of Periodicity of Desire

"It is possible to represent my law of Periodicity of Recurrence of desire in women graphically as a curved line; a succession of crests and hollows as in all wave-lines. Its simplest and most fundamental expression, however, is generally immensely complicated by other stimulations which may bring into it diverse series of waves, or irregular wave crests. We have all, at some time, watched the regular ripples of the sea breaking against a sand-bank, and noticed that the influx of another current of water may send a second system of waves at right angles to the first, cutting athwart them, so that the two series of waves pass through each other.

Variations

"Woman is so sensitive and responsive an instrument, and so liable in our modern civilized world to be influenced by innumerable sets of stimuli, that it is perhaps scarcely surprising that the deep, underlying waves of her primitive sex-tides have been obscured, and entangled so that their regular sequence has been masked in the choppy turmoil of her sea, and their existence has been largely unsuspected, and apparently quite unstudied.

"As it bears very intimately on the subject of the present chapter, a short and simple account of my conclusions on woman's rhythmic life must be given here.

"There are a good many slight variations among us, ranging from a three- to a five-week "month," but the majority of the women of our race have a moon-month of twenty-eight days, once during which comes the flow of menstruation. If we draw out a chart with succeeding periods of twenty-eight days each, looking on each period as a unit: When in this period is it that a normal healthy woman feels desire or any up -welling of her sex-tides?"

Typical Charts Possible

"The chart given opposite may assist in making graphically clear what has been said in these last few pages. It is compounded from a number of individual records, and shows a fair average chart of the rhythmic sequence of superabundance and flagging in woman's sex-vitality. The tops of the wave-crests come with remarkable regularity, so that there are two wave-crests in each twenty-eight-day month. Then one comes on the two or three days just before menstruation, the other after; but after menstruation has ceased there is a nearly level internal, bringing the next wave-crest to the two or three days which come about eight or nine days after the close of menstruation—that is, just round the fourteen days, or half the moon-month, since the last wave-crest. If this is put in its simplest way, one may say that there are fortnightly periods of desire, arranged so that one period comes always just before each menstrual flow. According to her vitality at the time, and the general health of the woman, the length of each desire-period, or as we might say, the size and complexity of each wave-crest, depends. Sometimes for the whole of as much as, or even more, than three days, she may be ardently and quite naturally stimulated, while at another time the same woman, if she is tired and overworked, may be conscious of desire for only a few hours, or even less.

Fatigue

"The effects of fatigue, city life, bad feeding, and, indeed, of most outward circumstances, may be very marked, and may for years, or all her life so reduce her vitality that a woman may never have experienced any spontaneous sex-impulse at all.

"The effects of fatigue, which reduces the vital energy, even in a normal, strongly sexed woman, can be seen in the second chart, where at a the intermediate wave-crest is very much reduced. This is not a generalized chart, but a detailed record of an actual individual case."

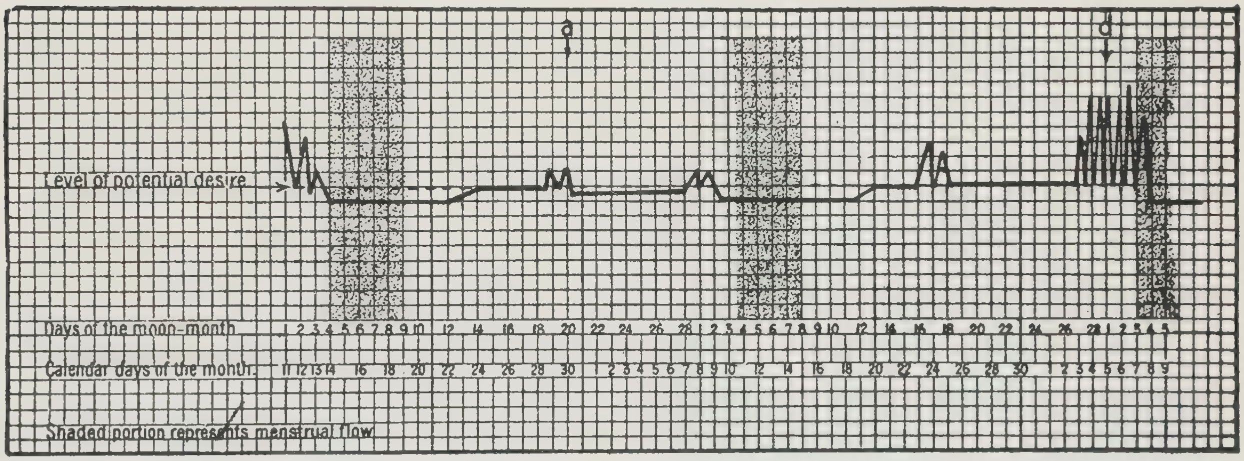
"After the most careful inquiries I have come to the conclusion that the general confusion regarding this subject is due partly to the great amount of variation which exists between different individuals, and partly to the fact that very few women have any idea of taking any scientific interest in life, and partly to the fact that the more profound, fundamental rhythm of sex-desire which I have come to the conclusion exists, or is potential, in every normal woman, is covered over or masked by the more superficial and temporary influences due to a great variety of stimuli or inhibitions in modern life. For the present consideration I have tried to disentangle the profound and natural rhythm from the more irregular surface waves."

14-Day Cycle Normal

"Curves similar to those shown represent in general terms a simplified view of what my research leads me to believe to be the normal, spontaneous sex-tide in women of our race. As one young married woman confided to me, her longing for bodily union with her husband, as distinct from her longing for his daily companionship, seemed to well up naturally like "clockwork," and this during his long absence. But human beings vary remarkably in every particular, and just as no two people have the same features, so no two people would have absolutely identical curves were they recorded in sufficient detail. Many a woman is particularly conscious of only one sex-impulse in each moon-month. Of such women, some feel the period which comes before menstruation and some feel the one which follows it. In those who generally feel only one, the second period is sometimes felt when they are particularly well, or only when they read exciting novels, or meet the man they love at a time coinciding with the natural, but suppressed, time of desire. There are a very few women, who seem to be really a little abnormal, who feel the strongest desire actually during the menstrual flow.

"....the old Jewish plan of having twelve clear days after the beginning of menstruation before the next union is in almost exact harmony with the law of Periodicity of Recurrence of women's desire shown in my charts."

CHART II.



Curve showing the depressing effects on the "wave-crests" of fatigue and overwork. Crest *a* represented only by a feeble and transient up-welling. Shortly before and during the time of the crest *d* Alpine air restored the vitality of the subject. The increased vitality is shown by the height and number of the apices of this wave-crest.

JOURNAL OF CYCLE RESEARCH

Vol. 1 No. 3

SPRING 1952

The third issue of the quarterly **Journal of Cycle Research** has just come from the printer. It is now in the mail to subscribers.

The issue is Vol. 1, No. 3 of the Journal. It contains 32 pages. It consists of the following material:

Editorial

The editorial, by Leonard Wing, editor of the Journal, and head of the Department of Wildlife Management at Texas Agricultural and Mechanical College, calls for a conference of cycle students.

Basic Data

The lead article, by Alla Malinowski of the Foundation Staff, develops an Index of Pig Iron Prices, 1784 to date, suitable for cycle analysis. The article is illustrated with two charts and includes the actual figures of the raw data and of the index.

Research

The second article, by me, shows the existence of a 17 3/4-year cycle in the Foundation's index of pig iron prices. It is illustrated with seven charts. It shows the amplitude and timing of the typical 17 3/4-year cycle in these figures. It projects the cycle into the future to show what will happen if this behavior continues.

Technical

The third article, by Charles E. Armstrong of the New York Telephone Company, is called "Testing Cycles for Statistical Significance—Applying the Bartels Test of Significance to a Time Series Analysis." It is a reprinting of a paper originally published by the Foundation in 1945 as Publication No. 12.

None of the tests of significance so far developed is entirely satisfactory but Bartels test is probably the best. This article explains in a simple way how to apply it to your own work.

erd

NEW COMMITTEE MEMBER

It is a great pleasure to be able to announce the election of Dr. Webster N. Jones as a member of the Committee of the Foundation for the Study of Cycles. Dr. Jones is now Dean of the College of Engineering and Science, Carnegie Institute of Technology, Pittsburgh, Pennsylvania.

Dean Jones graduated from the University of Missouri in 1908 and obtained his doctor's degree at Harvard in 1920. He was an instructor of Chemistry at Purdue University, 1909-10; Austin teaching fellow at Harvard University, 1910-12; instructor of chemistry at the University of Maine, 1912-13, University of Missouri, 1913-14, Radcliffe College, 1914-15; assistant professor of chemistry, University of Montana, 1915-18; research chemist B. F. Goodrich Company, 1919-24; manager of the General Chemical Laboratories, 1925-27, technical superintendant 1927, general superintendant processing division, 1928-32. Since 1932 he has been associated with the Carnegie Institute of Technology at Pittsburgh.

Dean Jones served as a first Lieutenant, U.S. Army 1918, chemical expert War Trade Board, 1919.

In World War II he was on the staff of the Baruch Committee on synthetic rubber, organized the office of Production, Research and Development, and has been a member of the National Inventors Council since its inception.

He is a member of the American Association for the Advancement of Science, American Chemical Society, American Institute for Chemical Engineers (president 1939-40), Society for the Promotion of Engineering Education, Engineers Society of Western Pennsylvania (president 1944), Engineers Council for Professional Development, Association of Harvard chemists (president 1930), the Pittsburgh Personnel Association, Alpha Chi Sigma, Sigma Xi, Phi Kappa Phi, Alpha Tau Omega, Scabbard and Blade.

He is a member of the Cosmos Club of Washington, the Chemist Club of New York City, and of the University Club of Pittsburgh.

Who's Who reports him as a Republican and a Presbyterian,

American Men of Science reports his specialties as engineering education, cyclopropanes, age resistors, and accelerators in rubber.

Dr. Webster N. Jones

Letters

How do Cycles Combine?

Dear Mr. Dewey:

From the general tenor of your writings in the monthly publication, "Cycles," I am sure you welcome a friendly dissenting opinion.

On page 290 of the October 1951 report you state as follows:

"If the amplitude of the 9-year cycle at crest is 120% of trend and the amplitude of the 41-month cycle at crest is also 120% of trend, and if the crests come together, the combined amplitude is 120% of 120% or 144% of trend."

Thus, to determine the combined amplitude of a group of cycles at any point of time, you obtain the product of their amplitudes at that time, rather than getting their sum. This procedure seems wrong to me.

Amplitude is the **effect** of a force which causes the item being considered (such as stock prices) to go alternately and rhythmically above and below its trend value with the passage of time.

The magnitude of this force may be expressed in terms of its effect,—as a percentage deviation of the item from its trend. In the case quoted above, the "force" of each of the two cycles would be 20%.

In engineering practice a force would be measured in pounds (or some equivalent). Now if there is one force (amplitude) of 20 pounds (instead of saying 20 **percent**) and it is combined with another force of 20 pounds, acting in the same direction, the result is a force (amplitude) of 40 pounds, as obtained by simple addition. Multiplication would give 400 pounds, which is obviously erroneous.

Hence I believe the proper method of combining amplitudes is addition (with due regard to plus and minus signs), instead of multiplication.

Now let's look at the problem from another angle. When you multiplied the 120% of the 9-year cycle and the 120% of the 41-month cycle you automatically made the 120% current value of the 41-month cycle become the "trend" value of the 9-year cycle. Instead, the percent amplitude of every cycle must be applied only to the basic common trend value. Otherwise the resultant amplitude of a group of cycles will be proportionately and progressively over-inflated with the addition of each successive cycle.

If addition is the correct procedure instead of multiplication it is obviously improper to add logarithms of amplitudes as this would, of course, be merely multiplication.

Your comments are invited.

Sincerely,
Herman P. Cortelyou
Los Angeles, California.

In reply I wrote:

Dear Mr. Cortelyou:

Whether Cycles should be added or multiplied depends not upon logic but upon how cycles do in fact combine. In all series that I have examined to obtain an answer to this question they do combine by multiplication. That is, the little waves are bigger in absolute value at the crests of big waves than they are at the troughs but percentagewise they seem to be the same.

You can determine this fact by inspection of any series where the major fluctuations have important amplitude. When such series are plotted on arithmetic paper the little waves flatten out at the troughs. When they are plotted on log paper the little fluctuations have about the same value at periods of trough as at periods of crest.

The only exception I know of to the above generalization is the behavior of sunspot numbers. In this series although the fluctuations flatten out in the troughs when plotted on log paper they are exaggerated in the troughs. To get fluctuations of equal magnitude at times of crest and trough one has to add a constant of about 8 to the original figures.

Referring again to your letter, you say that amplitude is the effect of a force which causes the item being considered to go alternately and rhythmically above and below its trend value. True. But for any one rhythmical force **its** trend is secular trend plus the composite effect of all the other cycles and random forces. In other words cycles manifest themselves as **percentage** effect. A force that causes a 10% fluctuation in the production of the United States Steel Corporation at the present time might have caused a 10% fluctuation in production in 1901 also, but the **absolute** fluctuation would be much less than at the present time.

Does this clear up the matter for you?

Very cordially yours,

Dear Mr. Dewey:

Thanks for your gracious and interesting reply to my letter concerning combining cycles by addition of their amplitudes rather than by multiplication.

In substance, you say (1) that regardless of what logic may indicate, cycles actually do combine by multiplication, (2) that this conclusion is based on your studies of many different series, (3) that "for any one rhythmical force, its trend is secular trend plus the composite effect of all the other cycles and random forces," and (4) that "little waves are bigger in absolute value at the crests of the big waves than they are at the troughs, but percentagewise they seem to be the same," (that is, in percent of the value of the big cycle at its crests and at its troughs).

According to my theory, the amplitude of a cycle is a percentage of the secular trend value alone, and the numerical effect of a small wave would be the same at both the crests and the troughs of the big wave. On a log scale chart of a composite of many cycles, the small waves would appear larger at the troughs of the big wave than at the crests. This, of course, is the direct opposite of your findings.

For a crude check of this, one may examine a log scale chart of the Dow-Jones Industrial average from 1897 to date. The small wave fluctuations seem to average wider (percentagewise) around the major lows than around the major highs. To be specific, look at the swings within the high area of 1928 and 1929 (prior to the panic break), and see how much smaller they are than the wide swings within the low area of 1931, 1932, and 1933. Also notice that the swings again become relatively small within the following high area of 1936 and early 1937.

So both logic and observation of a stock price chart seem to support the theory of addition. On the other hand, I realize that you have made very extensive and meticulous studies of the matter and your conclusions must therefore carry great weight. I wonder what other cycle students have concluded?

Thanks for your patience and courtesy.

Sincerely,
Herman P. Cortelyou
Los Angeles, California.

Dear Mr. Cortelyou:

I am afraid you give too much weight to my "very extensive and meticulous studies." I have not studied this matter anywhere nearly as much as I would like to and it is perfectly possible that I am wrong.

My belief that cycles combine percentagewise is based on an impression received from working with a good many series, but I have not made the numerous and specialized studies that you credit me with.

Why not put the matter to the test and take some short wave that has been present consistently throughout a long series of figures, averaging its amplitude separately for those portions of the curve that are above and below the trend respectively? This will tell us whether your idea is right, or mine, or something between the two.

Very cordially yours,

Electric Brains

Dear Mr. Dewey:

Could you tell me if any of the available so-called electronic brains or computers are adapted to the isolation of cycles in prices and, if so, which ones? Also, what form should the data be put into and can you give me the approximate cost of isolating rhythms in cotton prices? It appears to me that this would be cheaper and faster than by any laborious calculating machine operation.

Very truly yours,
R. I. Abbay, Jr.

Dear Mr. Abbay:

I do not believe that any of the electric brains we read about in the papers are suitable for the isolation of cycles, even if we could succeed in obtaining the use of one.

I do not mean that they could not be set up in such a way as to isolate cycles. The trouble is that it would take more time and cost more money to set up the machine to do the job than the result would be worth.

There are, however, electrical, optical, and mechanical machines designed especially for harmonic analysis. Some of these machines are described briefly on pages 26 and 27 of our October 1950 report. I believe that one of these machines would serve your purpose much better and much more cheaply than the better-known electric brains that are doing such marvelous work nowadays.

In spite of the virtues claimed for optical machines and electrical machines (one of which was described quite fully in the September and October 1950 monthly reports), my own preference is for mechanical analyzers of the sort pictured on page 21 of our September 1950 report and repictured on page 377 of the report for December 1951. [See also page 179 of this issue.]

We have just completed a rather extensive multiple harmonic analysis of railroad stock prices, industrial stock prices, pig iron prices, and the sales of an individual manufacturing company. The results of these analyses are being published as fast as possible in our monthly reports starting with the April 1952 issue, now at the printer.

The description of these studies should be of some use to you in connection with your own thinking because they indicate some of the limitations of this approach. One of these limitations is that the machine gives you only hints of cycles. The machine cannot distinguish between accidental variations and rhythmic cycles. A second limitation is that even if the cycles are real the machine cannot be counted upon to give you their true length.

On the other hand, the machine has three very definite advantages. The first of these is that the machine has no preconceived notions as to what cycle lengths "ought" to be present; second, the machine gives you a comprehensive and simultaneous picture of all important cycles that might be in the series; and third, as you say in your letter, the machine saves an enormous amount of work. Through the use of the machine we were able to do in a couple of weeks an amount of work that would have taken a statistician 6 1/2 years with paper and pencil and an ordinary Monroe or Friden calculator.

You asked two other questions, in what form should the data be put and what is the cost of work of this sort.

For use on the mechanical harmonic analyzer manufactured by the Mico Instrument Company, which is the only machine that can be used successfully for multiple harmonic analysis, logs of data should be charted on ordinary arithmetic chart paper not more than 45 centimeters wide and not over 30 centimeters high. In other words, about 12" x 19".

As for cost, the Mico Instrumrnt sells for about $12,000. The actual cost of running a series of curves through the machine is merely the time to set up the work, run the charts through the machine, and make the necessary supplemental calculations (plus, of course, travel expense). You can get some idea of this cost from the fact that the job we just did cost about $1,700.

Cordially yours,

Questions and Answers

Q. Since there are an unlimited number of harmonic constituents in a curve, how can accuracy in analysis be obtained by the use of a selected group?

A. The answer is that you cannot obtain complete accuracy by the use of a selected group; the more constituents you use the closer you can come to the accuracy you desire.

However, let me emphasize again that the harmonic constituents of a curve are merely mathematical building blocks and have no necessary relationship to reality. In other words, if you took an unlimited number of harmonic components and obtained complete accuracy you would have merely a copy of the original curve. You could get this copy much more easily by taking a photograph. A projection of the harmonic constituents involved would have no forecasting value whatever.

For forecasting purposes you have to find cycles that are really present. This is a very different thing from computing the mathematical abstractions involved in pure harmonic analysis.

Q. What effect has the Korean War had on the timing of cycles?

A. It has been my experience that wars generally distort the longer cycles but that the shorter cycles often continue without distortion right through a war period.

The present distortions are caused not only by the Korean War but also by preparation for World War III.

Q. Do you think it possible that rhythms are governed by specific laws of unknown nature?

A. Insofar as they are not the result of accident I suspect that they are, but as yet no one knows what these laws may be.

An interesting observation in connection with laws governing rhythm length will be printed in the June 1952 report.

Q. Why is the Hoskins Time Chart used when it fails to give shape, amplitude, or length as accurately as do other methods of cycle analysis?

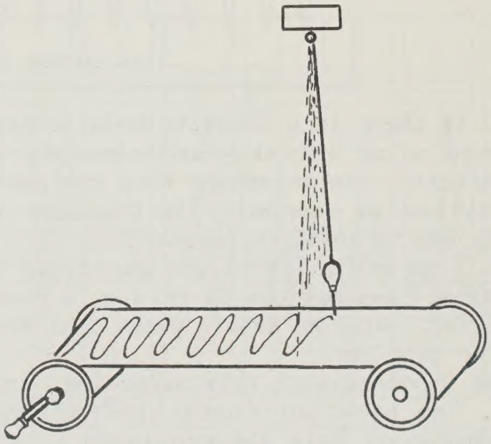
A. The Hoskins Time Chart has the incomparable advantage that it never loses slight of the individual cycles or waves. Also it is objective, quick, and easy to use, and gives more information per hour spent than is given by any other method I know about.

Q. Would you please clarify the term "sine curve?"

A. A sine curve is a curve of the shape that you would get if you traced the movement of a pendulum upon a sheet of paper moving underneath it at right angles at a uniform rate of speed.

Sine curves are all regular and simple, but they differ considerably in appearance depending upon the relation of the amplitude or height of the waves and their length or frequency. However, in spite of this difference in appearance, they all have the same general mathematical properties.

The figure below taken from **The Science of Musical Sounds** by Dayton C. Miller of the Case School of Applied Science of



Tracing a simple harmonic curve.

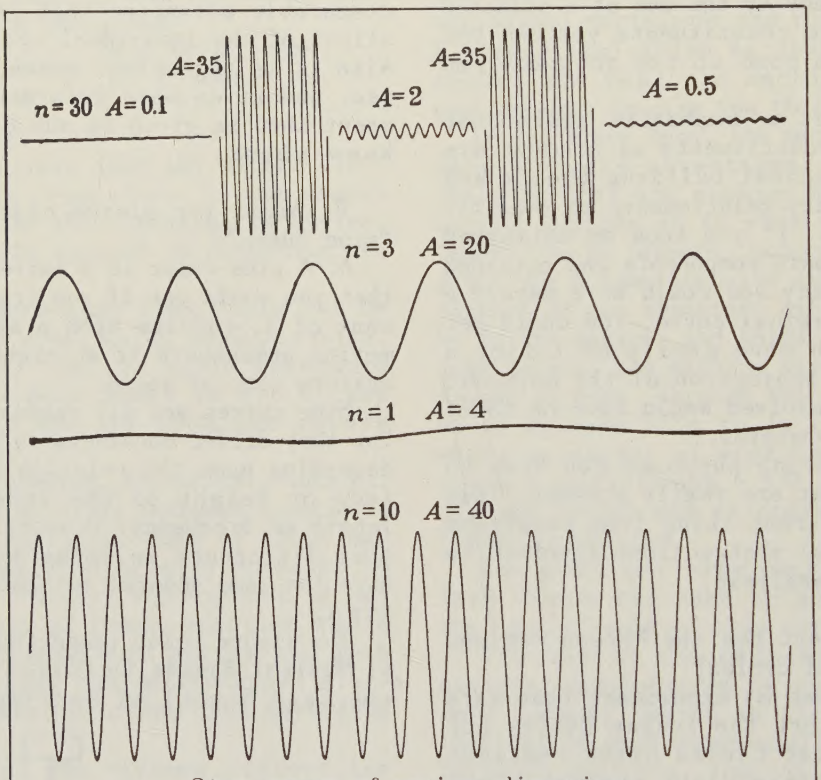
Cleveland, Ohio, shows seven different curves all of which are sine shaped. The difference in appearance is due to the different relative relationships between the length and the heigth of the waves.

In the diagram "n" gives you the frequency of the waves. "A" gives you the amplitude. For the scale chosen n means the number of waves for each two inches across the page. For the five waves in the first line you have n = 30 (that is, 30 waves in two inches, or 15 waves per inch). In this instance, the different shapes are due to the different amplitudes which are $\frac{1}{10}$, 35, 2, 35, and $\frac{5}{10}$ respectively.

In the second row n = 3 (that is to say, three waves in two inches or 1½ waves per inch). In this curve the amplitude is 20.

The next curve has one wave in two inches with an amplitude of 4.

The bottom curve has 10 waves in two inches, or 5 waves per inch, with an amplitude of 40.



Sine curves of various dimensions.

Q. If there is a definite relationship between solar activity and atmospheric electricity, can we assume that the cause of rhythms in economic fluctuations is partly due to solar radiation?

A. I do not think we are justified in making any assumptions in regard to cause and effect until we know a great deal more than we know now.

One hypothesis in this direction, however, has been put forth by Professor Huntington of Yale and reprinted in our report for April 1952.

Q. After synthesis of a group of rhythms has been obtained, can projection of this synthesis into the future be accomplished without going back to the analysis stage and projecting each rhythm separately?

A. No.

Q. Will an electrical spectrum analysis machine ever be available?

A. Machines of this sort are available now but, in the present state of their development, are not as satisfactory as mechanical machines.

Additions to the Library

"Historic firsts: Sun spots and radio," **Bell Laboratories Record**, Vol. XXVIII, No. 6, June 1950. Two pages, one chart.

Normal alternation between day and night radio transmission is shown by the curves February 11th to February 25th inclusive. Decidedly abnormal behavior is shown between then and the latter part of April, when the normal cycle showed signs of returning. (See Fig. 1.)

This article tells how C. N. Anderson in 1923 discovered that in all cases magnetic storms preceded or accompanied the periods of disturbance in radio transmission.

● ● ●

"On the Interpretation of the Results of Periodogram Analysis and of Self-Correlation," by H. W. Clough, **Bulletin American Meteorological Society**, Vol. 23, September 1942, six pages. References. Gift of Mr. Clough.

"Two rigid methods of disclosing periodicities, the periodogram analysis and self-correlation, are discussed, and several examples of their use in deriving the 28-month period in solar and meteorological data are given. The empirical or non-rigid method of deriving periods, illustrated by the determination of the epochs of sunspot maxima and minima, is contrasted with the rigid method, and it is shown that if the results by the two methods are properly interpreted, they are in substantial agreement."

● ● ●

"Glacial Clays in Steep Rock Lake, Ontario, Canada," by Ernst Antevs, **Bulletin of the Geological Society of America**, Vol. 62, pp. 1223-1262, October 1951, 40 pages, 6 plates, 9 tables, 11 figures, references. Gift of the author.

This bulletin contains actual millimeter thicknesses of varves (sedimentary rock deposits), i.e. the raw material from which cycle studies can be made.

● ● ●

"Upland Game in Western Canada," by R. M. Ferrie, a paper presented under the auspices of the Western Canada-Yukon Fish and Game Council. Six pages, three charts.

See extended review on page 180.

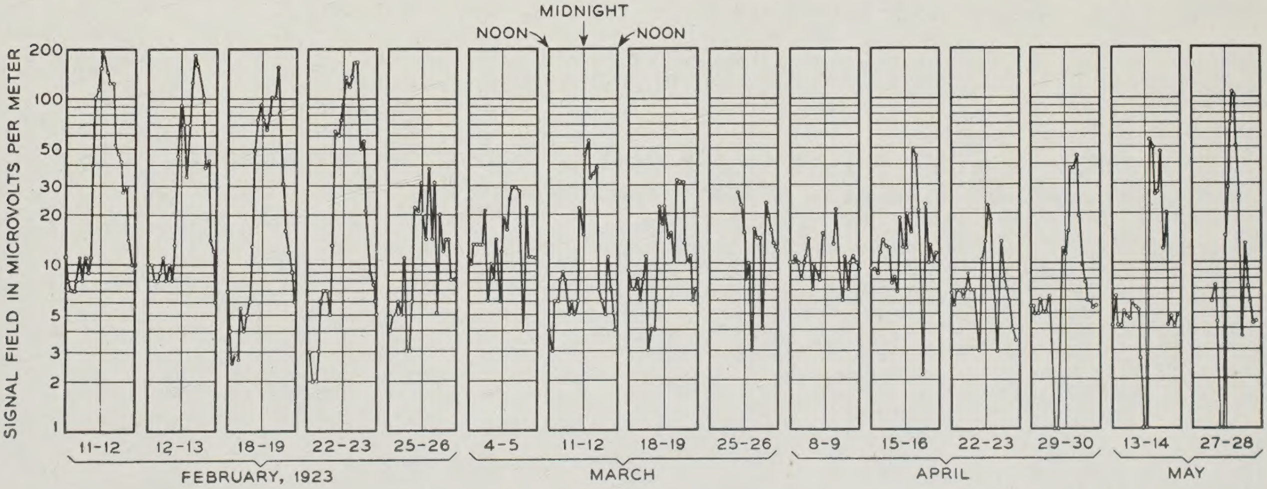


Fig. 1. The daily cycle of the radio transmission field for various days in 1923.

Mr. H. A. Musham
741 No. Rush St.
Chicago, Ill.

March
#3011

FELLOWSHIP AVAILABLE!

The Foundation announces the creation of three Fellowships, each to run for three years. These Fellowships were created to enable qualified students to spend full time at Foundation headquarters in the study of the subject of cycles.

One of these Fellowships has already been financed. The problem now is to find a suitable Fellow. Are you interested or do you know of anyone who might be interested?

The Fellow will live, rent free, in an 8-room house adjacent to research headquarters of the Foundation at East Brady, Pennsylvania, and will receive a stipend adequate for the support of himself and his family. If you are interested, write to the Director of the Foundation, giving your qualifications and the amount of money that you would require.

If you are not interested yourself, please try to get some other qualified person to make an application.

Foundation for the Study of Cycles
Research Headquarters
East Brady, Pennsylvania

P. S. Would you like to pledge $35. a year for three years toward the financing of the second Fellowship?